THE RESOURCES AGENCY OF CALIFORNIA

Department of Water Resources

BULLETIN No. 101

DESERT AREAS OF SOUTHEASTERN CALIFORNIA LAND AND WATER USE SURVEY, 1958

JANUARY 1963

EDMUND G. BROWN
Governar
State of Califarnia

WILLIAM E. WARNE
Administrator
The Resaurces Agency af Califarnia
and Director
Department of Water Resources

Irrigated Agriculture in Coachella Valley

State of California
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ADDRESS REPLY T
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THE RESOURCES AGENCY OF CALIFORNIA
DEPARTMENT OF WATER RESOURCES
1120 N STREET, SACRAMENTO

December 18, 1962

Honorable Edmund G. Brown, Governor, and
Members of the Legislature of the
State of California

Gentlemen:

I have the honor to transmit herewith Department of Water Resources Bulletin No. 101, entitled "Desert Areas of Southeastern California Land and Water Use Survey, 1958." The report has been prepared as a part of the department's continuing program of studies of the use of the water resources of the State to provide the basis for planning water development, pursuant to Sections 225, 226, and 232 of the California Water Code.

The report treats those areas of Kern, Los Angeles, San Bernardino, Riverside, San Diego, and Imperial Counties that drain internally into lakes or dry lake beds, and the easterly portions of San Bernardino, Riverside, and Imperial Counties tributary to the Colorado River. It presents data concerning land use and estimates of water use thereon as of 1958, and evaluates the changes in land and water use since the last survey of the area was made in 1950. This information will be useful to those agencies concerned with making the most effective use of existing water supplies and in development of plans for additional water supplies to meet current or expected deficiencies.

The results of the 1958 survey of land and water use in the desert areas of southeastern California indicate that during the period from 1950 through 1958 the gross irrigated agricultural acreage increased from 642,800 acres to 800,900 acres, a growth of about 158,100 acres, or 25 percent. These increases occurred primarily on lands within the Coachella Valley, Imperial Valley, and Colorado River Hydrographic Units which are, for the most part, within service areas provided with water from the Colorado River. The population in the southeastern desert areas increased from 177,000 to 350,300 in 1960, or 98 percent. A direct result of the population growth has been an expansion in the gross urban

Honorable Edmund G. Brown, Governor, and
Members of the Legislature of the
State of California

and suburban area by 50,000 acres, or 182 percent. The estimated mean seasonal level of total net water uses in this area increased from about 3,429,000 acre-feet in 1950 to 3,658,000 acre-feet in 1958, an increase of 229,000 acre-feet, or about 7 percent.

The increasing need for water in the desert areas of southeastern California, coupled with already deficient local water supplies in many localities, points up the need for participation by residents of this area in statewide planning and construction of water resources developments.

Sincerely yours,

William E. Warne

Director

ACKNOWLEDGMENT

Valuable assistance and data used in this investigation and report were contributed by numerous public and private agencies whose cooperation is gratefully acknowledged. In this regard, special mention is made of the assistance and data received from the following:

Imperial Irrigation District

Riverside County Agricultural Commission

University of California Agricultural Extension Service

STATE OF CALIFORNIA
THE RESOURCES AGENCY OF CALIFORNIA
DEPARTMENT OF WATER RESOURCES

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CHAPTER I. INTRODUCTION

The widespread belief that desert areas consist only of vast reaches of barren, desolate waste lands, totally devoid of water and continuously subject to extreme heat, is a common misconception. For despite the extremely high summer temperatures and the apparent lack of water, man has created an extensive cultural development in the desert areas of southeastern California, changing the character of the land with his works. Particularly in those regions of the desert area where man has developed a stable and dependable water supply, based on native ground water stored in underground reservoirs or water imported from other areas, has the desert been transformed into fertile, green farm land.

This report indicates the inroads that man has made in the desert areas of southeastern California by 1958, and presents information on the rate of development and the increasing needs of this cultural development for water. It is one of a series of bulletins presenting the results of studies made by the Department of Water Resources pursuant to legislative directive, and contains the results of a land and water use survey conducted in the southeastern desert area of California during the summers of 1957 and 1958.

Land use information is gathered to obtain basic data from which present water requirements can be computed. A knowledge of historical and current patterns of land use not only permits such computations but, of more importance to the overall planning concept, permits an analysis of the direction and magnitude of land use changes taking place from one survey to another. This information, coupled with computations of changes

in water requirements provides the basis upon which future water requirements are determined, and upon which the planning for importation and distribution systems is carried out. The material presented herein is intended for the use of responsible agencies in making the most effective use of existing water supplies and in developing additional supplies to meet current and expected deficiencies.

Authorization

The California Legislature of 1929 enacted legislation designated Chapter 832, Statutes of 1929, quoted in part as follows:

> "SECTION 1. Out of any money in the state treasury not otherwise appropriated, the sum of four hundred fifty thousand dollars,* or so much thereof as may be necessary, is hereby appropriated to be expended by the state department of public works in accordance with law in conducting work of exploration, investigation and preliminary plans in furtherance of a coordinated plan for the conservation, development and utilization of the water resources of California including the Santa Ana River and its tributaries, the Mojave river and its tributaries, and all other water resources of southern California."
>
> * Reduced by the Governor to $390,000

Subsequent sessions of the Legislature have appropriated funds for support of the Division of Water Resources and the Department of Water Resources. Portions of these funds have been utilized for continuing investigations of the water resources of southern California and the utilization thereof in accordance with the legislative intent expressed in the foregoing statute and in Sections 225 and 226 of the California Water Code.

Section 232 of the Water Code, added by Chapter 61, Statutes of 1956 (First Extra Session), further directed the Department of Water Resources to make continuing investigations to develop "information as

to water which can be made available for exportation from the watersheds in which it originates without depriving those watersheds of water necessary for beneficial uses therein." This legislation specifically requested investigation of the following matters:

> "(a) The boundaries of the respective watersheds of the State and the quantities of water originating therein; (b) The quantities of water reasonably required for ultimate beneficial use in the respective watersheds; (c) The quantities of water, if any, available for export from the respective watersheds; and (d) The areas which can be served by the water available for export from each watershed; (e) The present uses of water within each watershed together with the apparent claim of water right attaching thereto, excluding individual uses of water involving diversions of small quantities which, in the judgement of the Director of Water Resources, are insufficient in the aggregate to materially affect the quantitative determinations included in the report."

Pursuant to the foregoing legislative directives, the Department of Water Resources began a program of continuing surveys of land and water use in the water-deficient southern California area during 1957. Surveys are made in one of five portions of the whole area each year, so that land and water use are determined at five-year intervals.

Scope of Investigation and Report

This report contains the results of a comprehensive survey conducted by the Department of Water Resources to determine the nature and extent of land and water use within the southeastern desert area of southern California. The area of investigation is shown on Plate 1, "Area of Investigation and Hydrographic Units."

Present land use was determined from an assimilation of three detailed field surveys. The department conducted a land and water use survey in the Antelope Valley and Mojave River areas during the summer of 1957 for use in the preparation of Bulletin No. 78, "Investigation of

Alternative Aqueduct Systems to Serve Southern California," and surveyed most of the remaining portion of the investigational area during the summer of 1958. Supplemental surveys were also conducted at three month intervals after the main summer survey in several areas subject to multiple cropping to determine crop patterns and water requirements. Imperial Irrigation District conducts quarterly inventories of crops grown within its boundaries, and the March 1959 survey of agricultural land use by that district was integrated into the main body of data for this report.

In addition to showing present land use, this report presents a narration of historical land use development and changes, and an estimate of the present levels of water use. Data obtained from the land use survey conducted in 1950 and presented in Bulletin No. 2, "Water Utilization and Requirements of California," were utilized as the basis for comparison between the 1950 and 1958 land use patterns and water requirements. Information on local water supplies and importations of water were obtained from operating agencies in the area of investigation, or developed from material in the department's files.

Terms used in this report, which require clarification, are defined at the point where they first occur in the text, and are supplemented by a list of definitions, presented in Appendix A.

Other appendixes presented with this report are Appendix B, Irrigated Agricultural Land Use in Imperial Irrigation District in June, September, and December 1958, and March 1959; Appendix C, Land Use in Ground Water Basins of the Lahontan Area of Southeastern California, 1958; and Appendix D, Land Use in Ground Water Basins of the Colorado Desert Area, 1958.

Related Investigations and Reports

The California Legislature of 1947, by Chapter 1541, Statutes of 1947, directed the Department of Water Resources and its predecessor agencies to conduct a comprehensive investigation of the water resources of the entire State of California. The investigation had as its purpose the preparation of the California Water Plan. Results of the investigation are contained in three publications: California Water Resources Board Bulletin No. 1, "Water Resources of California," 1951; California Water Resources Board Bulletin No. 2, "Water Utilization and Requirements of California," June 1955; and California Department of Water Resources Bulletin No. 3, "The California Water Plan," May 1957. The investigations for Bulletin No. 2 included a survey of land use in 1950 and a determination of water utilization in the southeastern desert area for conditions of 1950.

The following reports also contain information pertinent to land and water use within the southeastern desert area:

Blaney, Harry F. and Ewing, Paul A. "Utilization of the Waters of Mojave River, California." United States Department of Agriculture. August 1935.

Brown, John S. "The Salton Sea Region, California." United States Department of the Interior, Geological Survey, Water Supply Paper 497. 1923.

California Department of Engineering. "Report on the Utilization of Mojave River for Irrigation in Victor Valley, California." Bulletin No. 5. 1918.

California Department of Public Works, Division of Water Resources. "Mojave River Investigation." Bulletin No. 47. 1934.

California Department of Public Works, Division of Water Resources. "Ground Water Occurrence and Quality, Colorado River Basin Region." Water Quality Investigations Report No. 4. May 1954.

Hall, William Hammond, State Engineer. "Irrigation in Southern California." 1888.

Huberty, M. R., Pillsbury, A. F., and Sokoloff, V. P. "Hydrologic Studies in Coachella Valley, California." University of California. June 1948.

Mendenhall, Walter C. "Ground Waters of the Indio Region, California." United States Department of the Interior, Geological Survey, Water Supply Paper 225. 1909.

Thompson, David G. "The Mojave Desert Region, California." United States Department of the Interior, Geological Survey, Water Supply Paper 578. 1929.

United States Department of the Interior, Bureau of Reclamation. "Report on Water Supply of the Lower Colorado River Basin." November 1952.

Courtesy Spence Air Photos

The Southeastern Desert Area is Characteristically a Reigon of Barren Mountain Ranges

CHAPTER II. AREA OF INVESTIGATION

The area under investigation, broadly designated the Southeastern Desert Area of California, consists of those lands generally easterly of the drainage divide of the Sierra Nevada, Tehachapi, San Gabriel, San Bernardino, San Jacinto, and Peninsular Mountain ranges. As shown on Plate 1, the area is bounded on the north by the Inyo-Kern, San Bernardino County line, on the east by the Nevada State line and the Colorado River, and on the south by the International Boundary between the United States and Mexico. This vast region, some 220 miles long and varying in width from about 110 to 230 miles, encompasses a total of approximately 34,000 square miles.

The area includes those portions of Los Angeles, San Bernardino, Riverside, San Diego, and Imperial Counties that drain internally into lakes or dry lake beds and that portion of Kern County southeast of the Tehachapi Mountains. The extreme easterly areas of San Bernardino, Riverside, and Imperial Counties that are tributary to the Colorado River are also included within the investigational boundaries.

The locations of the major ground water basins within this area are shown on Plate 2, "Ground Water Basins." Portions of some minor drainage basins lie in Nevada, however, this investigation was limited to the area within California's boundaries.

Climatic Conditions

The climate of the desert area varies widely with topography and latitude. During the winter, temperatures below 32°F are common in the high mountain ranges forming the westerly boundary of the area and frequently occur over much of the higher desert expanses to the north

and northwest. In contrast, the winters are typically short and mild throughout the lower southerly section of the area. The entire area is characterized by hot summers with low humidity and scant rainfall, and there is a marked contrast between day and night temperatures, both seasonally and diurnally.

Precipitation, although extremely light and irregular over nearly the entire area, is the major source of replenishment to the ground water basins, except those ground water reservoirs in the southeastern portion which are replenished by deep percolation of applied Colorado River water. Snowfall is common in the high mountains during the winters, and also occurs occasionally on the high desert areas to the north and northwest. Mean seasonal precipitation for the 50-year period from 1897-98 to 1946-47 at Big Pines Park in the San Gabriel Mountains is 25.6 inches, and at Raywood Flats in the San Bernardino Mountains, 37.8 inches. Typical mean seasonal depths of precipitation in desert valleys are 4.9 inches at Mojave, 7.0 inches at Lancaster, 4.1 inches at Barstow, 5.5 inches at Victorville, 3.6 inches at Indio, 3.2 inches at El Centro, 4.0 inches at Blythe, and 4.8 inches at Needles. Generally, precipitation over the entire area occurs from November through April, although local thunder storms occurring at random intervals may, during some years, contribute much more than the equivalent of average seasonal precipitation to local areas in very short periods. At several stations within the area only a trace of precipitation has been recorded for entire seasons.

Cultural Development

The southeastern desert area of California is characteristically a region of barren mountain ranges and isolated hills surrounding

broad valleys or basins. Development is for the most part confined to relatively flat valley areas where water supplies are available. A large portion of this area is entirely dependent on ground water for water supplies.

Irrigated agriculture is still the leading economic activity throughout most of the desert area. The largest irrigated acreages are found in Coachella, Imperial, Palo Verde and Yuma Valleys and are made possible by diversions from the Colorado River. Large acreages are also irrigated in Antelope and Mojave River Valleys by the use of ground water. In general, the total irrigated acreage has steadily increased through the years, although decreases in acreage have resulted from declining ground water levels and consequent increases in the costs of pumping water in Antelope Valley and some smaller areas.

Development of industries which are dependent on agricultural production have closely followed the agricultural growth. In addition, the establishment of several major military installations, including flight and missile testing facilities and related production plants, has resulted in large-scale industrial expansion, particularly in Antelope Valley.

The desert area has been a center of mining interest for nearly 100 years. A large number of minerals has been found throughout the desert, and many of these are mined and marketed. Water requirements for these mining operations are small in relation to irrigation requirements and have usually been met by pumping from local supplies of ground water or by diversions from springs.

Population in the desert area historically has been an adjunct to agricultural activity and to mining in a lesser degree. The cities and urban communities are characteristically widely scattered and relatively small. Notable exceptions to this, within the last two decades,

are the increases in population traceable to the establishment of major military and related aircraft industrial installations in and around Lancaster and Palmdale, and the recreational development surrounding the cities of Palm Springs, Desert Hot Springs, and Twentynine Palms. Table 1 shows population trends in ten representative cities from 1940 to 1960, as well as two unincorporated urban centers. The unincorporated urban centers do not have fixed boundaries so the population figures through the years are not entirely comparable. Table 2 shows increases in population for the areas of the portion of each county contained within the southeastern desert area for the years 1940, 1950, and 1960.

TABLE 1

POPULATION OF PRINCIPAL URBAN CENTERS
SOUTHEASTERN DESERT AREA

City	Years		
	1940	1950	1960
Lancaster*	2,100	3,600	26,000
El Centro	10,000	12,600	16,800
Palm Springs	3,400	7,700	13,500
Brawley	11,700	11,900	12,700
Barstow	2,100	6,100	11,600
Banning	3,900	7,000	10,200
Indio	2,300	5,300	9,700
Victorville	2,000	3,200	8,200
Calexico	5,400	6,400	8,000
Blythe	2,400	4,100	6,000
Needles	3,600	4,100	4,600
Mojave*	1,200	2,100	1,800

*Unincorporated areas.

TABLE 2

POPULATION OF COUNTIES OR PORTIONS OF COUNTIES
WITHIN SOUTHEASTERN DESERT AREA

County	Years		
	1940	1950	1960
Kern	1,500	11,500	36,700
Los Angeles	7,700	16,100	68,200
San Bernardino	18,200	39,400	89,500
Riverside	23,100	45,400	81,800
Imperial	59,700	63,000	72,100
San Diego	600	1,600	2,000
Totals	110,800	177,000	350,300

Since World War II there has been a general awakening of interest in the desert as an answer to the recreational needs of the growing California population. This interest has stimulated a remarkable rate of population growth in the recreational areas and a new pattern of land use is developing. Commercial and industrial enterprises are also developing to support the growing population centers.

Hydrographic Units

On the basis of cultural development, surface drainage, and geological considerations related to the occurrence of ground water, the desert area has been broadly subdivided into nine major hydrographic units. These units and their numerical designations are: Death Valley (6-10), Mojave River (6-11), Antelope Valley (6-12), Twentynine Palms (7-1), Coachella Valley (7-2), Salton Sea (7-3), Imperial Valley (7-4), Colorado River (7-5) and Lanfair Valley (7-6). The boundaries of these

units, shown on Plate 1, correspond to those into which the southern portion of the Lahontan area and the entire Colorado River area were subdivided for use in Bulletin No. 2, with the exception that the Death Valley Unit has been arbitrarily split at the Inyo-Kern, San Bernardino County line for the purposes of this study. The gross areas of these units are presented in Table 3. The areas of that portion of each county included within the southeastern desert area are given in Table 4.

TABLE 3

AREAS OF HYDROGRAPHIC UNITS
SOUTHEASTERN DESERT AREA

Hydrographic unit		Acres
Death Valley	(6-10)	4,422,000
Mojave River	(6-11)	3,140,000
Antelope Valley	(6-12)	1,546,000
Twentynine Palms	(7- 1)	3,867,000
Coachella Valley	(7- 2)	1,355,000
Salton Sea	(7- 3)	1,898,000
Imperial Valley	(7- 4)	1,007,000
Colorado River	(7- 5)	2,254,000
Lanfair Valley	(7- 6)	2,035,000
APPROXIMATE TOTAL		21,524,000

TABLE 4

AREAS OF COUNTIES WITHIN
SOUTHEASTERN DESERT AREA

County	Acres
Kern	1,624,000
Los Angeles	723,000
San Bernardino	12,275,000
Riverside	3,510,000
Imperial	2,587,000
San Diego	805,000
APPROXIMATE TOTAL	21,524,000

A brief description of the physiography, cultural development, and water supply and use in each of the hydrographic units is given in the remaining portion of this chapter.

Death Valley Unit (6-10)

The boundaries of the Death Valley Unit correspond to those of a similar hydrographic unit previously delineated in Bulletin No. 2, except that for this investigation only that portion of the earlier unit located south of the Inyo-Kern, San Bernardino County line has been included in the survey. The boundaries of the unit, shown on Plate 1, are the Nevada-California State line on the northeast, the drainage divide of the Mojave River and Antelope Valley on the south, the drainage divide of the Tehachapi and Sierra Nevada Mountains on the west, and the Inyo-Kern, San Bernardino County line on the north. The area encompassed by this unit is about 6,900 square miles.

There are no perennial streams in the area of this hydrographic unit. The Amargosa River, which is the largest intermittent stream

system in the area, originates in southwestern Nevada. Its course traverses eastern Inyo County, loops through northeastern San Bernardino County, and re-enters Inyo County, terminating in Death Valley. Even through the Amargosa River drains a large area, surface flow in its lower reaches is rare. Ground water has been extracted by wells located along the river for limited domestic and irrigation use. However, available information indicates that the high salt content of the ground water in the lower reaches of this stream valley generally precludes its use for domestic or agricultural purposes.

Many attempts have been made by homesteaders and others to develop and irrigate parts of other valleys in this area of the desert beginning shortly after the turn of the century. These attempts have for the most part ended in failure primarily because of insufficient supplies of good quality ground water. However, in the western section of the Death Valley Unit, irrigated acreages exist today in portions of Indian Wells Valley near the town of Ridgecrest, in Fremont Valley near Cantil, and in Harper Valley located a short distance northwest of Barstow. In 1957, irrigated agricultural acreages in these valleys were about 600, 5,600, and 2,200 acres, respectively. Available information indicates that larger acreages have been irrigated in the past, however, declining ground water levels, particularly in Harper Valley, have resulted in some decrease in irrigated acreage. The principal crops are alfalfa, field crops, and pasture.

The raising of livestock is another agricultural activity in this area, and cattle are grazed over much of the lands, particularly in the eastern and western sections.

Mining has been rather extensively developed in this area with the extraction of saline deposits from Searles Lake, an almost continuous operation since 1873. Several talc mines are located in northeastern San Bernardino County, and over the years many other mineral and salt deposits have been intermittently mined, particularly in the eastern section of the Death Valley Unit.

Industrial development has been somewhat limited although there are some light industrial facilities on the military reservations in the area, and a few mineral processing plants in operation, usually near the mineral deposits.

Mojave River Unit (6-11)

The Mojave River Unit is located in San Bernardino County in the north central section of the area of investigation and contains an area of about 4,900 square miles; the unit boundaries are shown on Plate 1.

The principal sources of water supply for the area within this unit are ground water and surface water from the Mojave River whose headwaters drain almost the entire northern slopes of the San Bernardino Mountains. The two larger tributaries of this river are Deep Creek and West Fork of the Mojave River, which are generally perennial in their upper reaches in the mountains and which join near the base of the mountains at an elevation of about 3,000 feet. Downstream from the confluence of these tributaries, the river traverses the Mojave Desert in a northerly direction for a distance of about 30 miles to Helendale. Its course is then northeastward some 20 miles to Barstow, where it turns eastward 40 miles to Soda Lake in the vicinity of Baker.

Surface flow in the Mojave River usually percolates rapidly into its pervious channel downstream from the mountains, except during high flow periods. However, even during dry periods rising water (outflow from the upstream ground water basins) appears as surface flow in the river channel at Victorville and at Afton. No significant tributaries contribute surface water to the river below the mountains, although some underflow is received from the mountains as far west as Sheep Creek.

The Mojave River Valley has been divided on the basis of physiographic and geologic features into three subbasins designated the Upper, Middle, and Lower Mojave River Valleys, and cultural development in this unit has been primarily centered in these valleys. The Upper Valley is a part of a broad piedmont plain that abuts the northern front of the San Gabriel and San Bernardino Mountains for a distance of about 100 miles. This piedmont plain, which includes Apple Valley on the east of the river and the Hesperia area on the west, slopes away to the north toward Victorville where it is bounded by the Middle Mojave River Valley. The ground surface elevation of this plain varies from about 4,000 feet at the base of the mountains to 2,500 feet at Helendale. The boundary between the Upper and Middle Mojave River Valleys is the Helendale fault which crosses the valley at Helendale. Bedrock barriers across the valley in the vicinity of Victorville bring ground water to the surface as perennial rising water.

The Middle Mojave River Valley is an irregularly shaped area extending from Helendale to Barstow. Its average elevation is about 2,500 feet. A natural geological barrier at Barstow separates the Middle and Lower Mojave River Valleys. Surface flow has occurred here in recent years only during short periods of high river flow. The Lower

Mojave River Valley is also irregularly shaped and trends toward the northeast. At its lower eastern end, the river discharges through Caves Canyon where perennial surface flow, rising ground water, is present in the vicinity of Afton. Beyond this canyon the Mojave River discharges into the desert expanses of the Soda Lake Basin south of Baker. Infrequent large floods in the upper reaches of the Mojave River watershed have produced considerable quantities of runoff into Soda Lake.

Significant cultural development in the Mojave River Valley began at an earlier date than in most other sections of the desert area. The Mojave River exhibits an uncommon hydrologic characteristic in this area, usually flowing as subsurface water, but appearing as rising surface waters at intervals along its desert reaches. It is believed that the availability of these rising waters, in an otherwise arid environment, was the primary factor in this early development.

Immigrants came to Southern California in increasing numbers beginning in the early 1830's from New Mexico and the east over the Spanish Trail; they struck the Mojave River at Soda Lake and followed it to the present vicinity of Helendale, then diverged to Cajon Pass and down on to the coastal plain. The first settlements were the stations on the trail located where lands were moist and the flow of the river was sufficient for the growing of hay to feed cattle and supply the freighters. It is believed that a few small ditches were in use for irrigation prior to 1870, and more permanent conduits were constructed from 1873 to 1880. Other choice locations upstream in the vicinity of Victorville and near the San Bernardino Mountains were also settled early.

Ground water development began prior to 1900 by use of hand-dug pits at points along the river where water was readily obtainable near the surface. Improvements in drilling techniques and pumping equipment after 1900 made possible more extensive ground water development. It has been reported that by 1915, a total of about 10,000 acres was being irrigated in the Mojave River Valley, 3,000 acres of this total by surface diversions and 7,000 acres by wells. About 120 wells were operating at this time, 90 of these were pumped and 30 were flowing. The flowing wells were located just above Victorville. The principal crops were apples, pears, and alfalfa. By 1929, this acreage had dropped to about 6,000 acres, planted mainly in alfalfa. The number of operating wells had increased to 257, of which 240 were pumped and 17 were flowing. In 1935, 6,000 acres were irrigated with only 290-300 acres of the total served surface water by ditches. The number of operating wells had decreased to approximately 200. The principal crop produced was still alfalfa, although dairying and poultry production were important agricultural activities. The 15-year period from 1935 to 1950 provided economic stimulus for more than a two-fold increase in total irrigated acreage which in 1950 amounted to 13,600 acres. Since 1950, the irrigated acreage declined slightly, dropping to 13,000 acres in 1958.

Ground water levels in the Mojave River Valley have generally remained fairly stable, which is a marked contrast to most other developed ground water areas in southern California. Historical data indicate that ground water level elevations in the Upper Mojave River Valley have decreased an average of about 15 to 20 feet during the period of record, because of the increased urban and agricultural development in the

Courtesy Spence Air Photos

Urban Development in Apple Valley, 1959

Victorville, Hesperia, and Apple Valley areas. Only minor lowering of ground water levels has occurred in Middle and Lower Mojave River Valleys.

Mining is the major industrial activity in Mojave River Valley, and various minerals of economic significance are found in the desert, particularly east of Barstow. Much of the activity connected with mining is sporadic, varying with fluctuating market conditions, but other industrial developments, such as the large cement manufacturing plants near Victorville and the military installations near Barstow, have been more stable and have stimulated urban development in and around these cities.

Antelope Valley Unit (6-12)

The Antelope Valley Unit is a major drainage basin in the northwestern portion of the area of investigation. This unit encompasses about 2,400 square miles, including those portions of Kern, Los Angeles, and San Bernardino Counties that drain to Rosamond, Rogers, and Mirage Lakes. As shown on Plate 1, this triangularly-shaped unit has its northern apex near Randsburg in Kern County, and an eastern boundary that roughly parallels the Kern-San Bernardino and Los Angeles-San Bernardino County lines before joining the San Gabriel Mountains on the south. The unit's southern boundary trends to the northwest generally along the drainage divide of the San Gabriel Mountains to the Tehachapi Mountains on the west; here, the boundary turns northeast along the drainage divide of the Tehachapis, returning to the northern apex.

The Antelope Valley receives runoff from the southeasterly slopes of the Tehachapi Mountains and the northeasterly slopes of the San Gabriel Mountains. Principal streams draining into the valley are Big Rock Creek and Little Rock Creek, both of which originate in the San Gabriel Mountains. Although these creeks and some other smaller

streams are perennial in their upper reaches, they are all intermittent in the valley.

Agricultural development in the Antelope Valley Unit has depended almost entirely on the success of obtaining adequate water supplies. In the early period of development prior to 1900, irrigated agricultural development was limited almost entirely to the southwestern fringe of the valley along the base of the San Gabriel Mountains where surface water supplies were utilized, although some dry-farmed grain was produced in the central and western part of the valley. It has been estimated that by 1895, about 10,000 acres along the base of the San Gabriel Mountains were irrigated through diversion of surface flow, producing crops of various deciduous fruits, nuts, and alfalfa. Because of the insufficient water supply this acreage was reduced within a short time and stabilized at about 2,000 to 3,000 acres, devoted mainly to deciduous fruits and alfalfa. This acreage has been maintained up to the present time by using surface diversions.

Ground water development in the valley prior to 1900 consisted of a few shallow domestic wells. With the advent of the deep well turbine pump around 1900, about 40 wells were constructed in the vicinity of Lancaster, mainly for irrigation of alfalfa. However, it was not until the introduction of electric power to Antelope Valley in 1914, that relatively large scale ground water development took place. This accelerated period of irrigated agricultural development continued until about 1929, at which time about 850 wells were being used for irrigation of about 25,000 acres planted mainly in alfalfa. During this period ground water levels in the valley began dropping appreciably, signalling the onset of the serious overdraft condition which exists today.

Courtesy Spence Air Photos

Urban Development and Agriculture in the Vicinity of Lancaster, 1958

During the decade of the 1940's, economic conditions stimulated additional large scale increases in agricultural development in the Antelope Valley Unit. By 1950, more than 1,000 wells were being operated for irrigation of a total of 70,000 acres. This trend has been reversed, however, and during the last ten years irrigated acreage in the valley has decreased somewhat, mainly because of increased pumping costs caused by severely declining ground water levels. In contrast to this decline in irrigated acreage, poultry production has become increasingly important to the area's agricultural economy, and now in terms of value of production, it is one of the most important agricultural enterprises.

Industrial activity in Antelope Valley prior to 1950 was minor in extent and was tied closely to agricultural development. During the past decade, however, there has been a marked expansion caused by the introduction of major military and related aircraft industrial installations located near Lancaster and Palmdale. Other major industrial developments in Antelope Valley include mining and mineral processing plants.

Twentynine Palms Unit (7-1)

The Twentynine Palms Unit encompasses a large desert region located within south central San Bernardino County and eastern Riverside County. As shown on Plate 1, the area of this hydrographic unit is bounded on the east by the Colorado River drainage divide; on the southwest by the San Bernardino, Little San Bernardino, and Chocolate Mountains; on the west and north by Mojave River Valley; and on the northeast by a line passing through the Old Woman Mountains in a northwesterly direction. This unit encompasses an area of about 6,000 square miles.

Although this area contains several internally drained basins, all streams in this hydrographic unit are ephemeral and ground water has supplied most of the needs of the culture which has developed here. However, supplies of good quality ground water in sufficient quantities to sustain domestic and agricultural development have been limited, and such development has occurred primarily in the Lucerne Valley and Twenty-nine Palms areas.

Early agricultural development, which commenced prior to 1900, was confined to stock grazing in the vicinity of Lucerne Valley and in Johnson Valley around Old Woman Springs. This activity has continued to the present, and in addition, about 2,000 acres planted mainly to alfalfa and pasture have been developed in Lucerne Valley. This is practically the only irrigated acreage located in the entire unit.

The oasis at Twentynine Palms has been a well known desert watering place during the period of available historical records. Until recently the population in the area surrounding Twentynine Palms remained quite small but short-lived increases occurred as a result of mining activity in the adjacent desert areas. In recent years, the area's equitable winter climate has been a prime factor in the large scale development of a week-end type resort area, and has also led to establishment of many permanent residences. In addition, the installation of a U. S. Marine Corp Training Center nearby has also encouraged an increase in the number of permanent residents in this area.

Industrial development in this region of the desert is restricted almost entirely to mining. Two large iron ore deposits, one located at the northeast end of the Eagle Mountains and the other near Twentynine Palms, are operated to supply ore to the Kaiser Steel Mill at

Fontana. Calcium chloride is mined from Bristol Dry Lake. Many other minerals and chemicals are mined throughout the region, although these operations are characteristically sporadic and vary with market conditions.

Coachella Valley Unit (7-2)

The Coachella Valley Unit lies in the west central part of the southeastern desert area primarily within south central Riverside County. This unit is bounded on the north by the San Bernardino Mountains, on the northeast by the Little San Bernardino Mountains, and on the east by the Orocopia Mountains. The southern boundary is arbitrarily drawn along the northwest shore of the Salton Sea, and is joined on the southwest by the San Jacinto and Santa Rosa Mountains. These boundaries are shown on Plate 1. The Coachella Valley Unit has an area of about 2,100 square miles, and varies in elevation from 235 feet below sea level at Salton Sea to 11,485 feet above sea level at Mount San Gorgonio.

The principal stream is the Whitewater River, which originates on the southeast slopes of Mt. San Gorgonio in the San Bernardino Mountains, discharges into the north end of the valley, and continues in a southeasterly direction to the Salton Sea. The channel of this river serves as the principal path for natural surface drainage from the valley to the Salton Sea, and is used to drain irrigation return water in the lower valley where the channel has been improved.

The principal tributaries of the Whitewater River are San Gorgonio River, and the Snow, Chino, Tahquitz, Palm Canyon, Deep Canyon, Mission, Big Morongo, and Little Morongo Creeks. Some of these larger tributaries are perennial streams in the mountains, but quickly percolate upon reaching the highly pervious alluvium in the valley. Natural

surface runoff from these streams, therefore, reaches the Salton Sea only during infrequent floods of large magnitude.

The first development of ground water in this unit occurred in 1894 when a well was drilled at Mecca, providing a supply of good quality artesian water. It was not until 1900, however, that improved methods of well construction and pumping equipment made available large quantities of ground water. By 1907, there were about 400 wells, many of them flowing, used for irrigation and domestic purposes in the region between Indio and the Salton Sea.

With water available for irrigation, land in the Coachella Valley Unit is well suited to the production of specialty crops because of the mild winter temperatures and sunny days which prevail. The principal crops have been truck crops, dates, citrus, and table grapes.

By 1936-37, a total of 15,500 acres was being irrigated in this area. The economic stimulus which occurred during the decade of the 1940's resulted in a two-fold increase in irrigated acreage, and by 1950 there were about 30,000 acres under irrigation. The first deliveries of Colorado River water, imported to the valley through the Coachella Branch of the All American Canal in April 1949, gave still another impetus to the growth of irrigated agriculture in this unit and by 1958, this development totaled about 68,000 acres.

Although there has been no major industrial development in this area, much urban development can be attributed to the vacation resorts which have proved particularly adapted to Coachella Valley, centering in the Palm Springs and Indio areas; and in addition, senior type retirement homes are becoming a major attraction within the valley.

Courtesy Spence Air Photos

Land Use Expansion in Palm Springs, 1940 to 1959

Courtesy Spence Air Photos

Salton Sea Unit (7-3)

The Salton Sea Unit is located in the southwestern and south central portion of the area of investigation, and encompasses the Salton Sea and parts of Riverside, Imperial, and San Diego Counties within its boundaries. As shown on Plate 1, this hydrographic unit is bounded on the north by the Santa Rosa and Orocopia Mountains, and on the east by a line passing southeasterly through the Chocolate Mountains. The southern boundary proceeds in an irregular line west from the Chocolate Mountains, turns north to the Salton Sea, then from the western side of the Salton Sea south again to the United States-Mexico International Border. The western boundary proceeds northward from the border along the crest of the Laguna and Cuyamaca Mountains, passes near Julian, and joins the northern boundary at the west end of the Santa Rosa Mountains. The area of this unit is about 3,000 square miles.

The upper watershed areas in this unit northwest of the Salton Sea are drained by Coyote and San Felipe Creeks; those to the southwest are drained by Vallecito and Carrizo Creeks, and those to the east of Salton Sea by Salton Creek. These creeks, and all other streams within the boundaries of this unit are ephemeral.

Although lack of adequate ground water supplies of good quality has seriously limited agricultural and other development in most of the Salton Sea Unit, 14 ground water basins have been delineated within its boundaries. Ground water pumped from some of these basins has supported intensive development; one notably, about 4,500 acres of irrigated agriculture in Borrego Valley, planted mainly in table grapes and alfalfa.

Industrial development has been negligible in this unit, but some urban development has occurred along the shores of the Salton Sea, based primarily on vacation resorts. However, even this development was limited by an inadequate supply of local water suitable for domestic purposes. In 1961 ground water from the Coachella Valley Unit was imported to portions of this unit.

Imperial Valley Unit (7-4)

The Imperial Valley Unit is located in the south central portion of the area of investigation, encompassing a portion of Imperial County which lies south of the Salton Sea. This hydrographic unit is bounded on the north by the Salton Sea and on the east by the Sand Hills. As shown on Plate 1, its southern boundary is the United States-Mexico International Border. To the west, it is bounded by the Coyote Mountains and the Fish Creek Mountains. This unit contains about 1,600 square miles which lie primarily below sea level.

The New and Alamo Rivers, which originate in the Mexicali Valley in Mexico and flow northward through the Imperial Valley to the Salton Sea, are the two major streams in this unit. Most of the flow of these rivers crossing the International Border is drainage water from irrigated portions of Mexicali Valley, although part of the flow of the New River originates as domestic and industrial wastes from Mexicali and Calexico. In addition, large volumes of seepage and drainage water from irrigated areas in Imperial Valley empty into the channels of these two rivers in their course towards the Salton Sea.

Ground water has never been developed to any appreciable extent in this unit, primarily because of its poor quality. The more

productive agricultural lands in the central portion of the valley are composed of sandy silts and clays of relatively low permeability; these sediments extend to considerable depths, and do not yield ground water in large quantities.

The use of Colorado River water in the Imperial Valley for irrigation was first conceived around 1860. However, delivery of water to the valley did not commence until June 1901, and the first major agricultural development occurred between 1909 and 1916. Imported water was delivered to the valley through the Mexican Canal System until 1942, when the All American Canal was placed in operation and began to transport water from Imperial Dam on the Colorado River to this area. The Imperial Irrigation District, which is the water service agency for this area, contains about 1,000,000 acres within its boundaries, including all of the irrigated area in the valley.

By 1943, some 400,000 acres were under irrigation within this unit with the principal crops being alfalfa, field crops, and truck crops. The irrigated acreage had increased to about 466,000 by 1958, and the principal crops remained unchanged, although larger acreages were being planted in small grains than in the past.

Major industrial development has not occurred in this unit, but the urban development has been somewhat more extensive in this area than in other units. The cities of Brawley, El Centro, and Calexico are railroad and trading centers, and development has centered primarily around the packing and shipping of agricultural produce on a year-round basis.

Courtesy Spence Air Photos

Imperial Valley near Calexico

Colorado River Unit (7-5)

The Colorado River Unit is located in the extreme easterly portion of the area of investigation, encompassing portions of San Bernardino, Riverside, and Imperial Counties. As shown on Plate 1, the area of this hydrographic unit is bounded on the north and east by the California-Nevada and California-Arizona state lines, respectively, and on the south by the International Border between the United States and Mexico. Its western boundary is formed by the drainage divide for streams in California that are directly tributary to the Colorado River and those which flow into interior sinks. The area of this unit is about 3,500 square miles.

All of the streams tributary to the Colorado River from California are ephemeral, flowing only after heavy rain storms, and are of minor significance to the area's water supply. The Colorado River, however, has long been an important source of water in this unit. Those sections of this unit adjacent to the Colorado River having established rights to the use of its waters are presently highly developed, primarily in irrigated agriculture.

The major irrigated agricultural developments in this unit are located in the Palo Verde Valley near Blythe, and the portion of the Yuma Project of the United States Bureau of Reclamation located in the extreme southeastern corner of California. Agricultural development of lands in the Palo Verde Valley date from 1877 when the first filing for water rights for the amount necessary to irrigate 40,000 acres was made. Although little development occurred until 1904, the completion of the first railroad connection to the valley in 1915 stimulated its growth; by 1950, the total irrigated acreage included about 55,000 acres, planted in alfalfa,

Courtesy Spence Air Photos

Agriculture Bordering the Colorado River in Palo Verde Valley

truck crops, grain, and pasture. In 1958, the irrigated acreage was about 72,000.

Water from the Colorado River is obtained by a diversion at the recently completed Palo Verde Dam and distributed by the Palo Verde Irrigation District. This district encompassed about 120,500 acres within its boundaries in 1959. Limited amounts of additional water for irrigation are obtained from wells, primarily on the mesa lands surrounding the Palo Verde Valley.

The Yuma Project, authorized in 1904, is a United States Bureau of Reclamation irrigation development and includes portions of California and Arizona adjacent to the Colorado River. The California portion of the project, designated the Reservation Division, contains about 15,000 acres. The Indian Unit contains about 8,000 acres, while the remaining 7,000 acres are allotted to non-Indian operators and comprise the Bard Irrigation District.

Industrial development has been limited in the Colorado River Unit, but the Colorado River area has become very popular as a recreational area in recent years. The mild winters with sunny days, and the excellent boating and fishing have drawn an increasingly large number of recreationists to this area.

Lanfair Valley Unit (7-6)

The northeast boundary of the Lanfair Valley Unit is the state line between Nevada and California. The east boundary is on the drainage divide of the Colorado River. The southwest boundary is a northwesterly trending line passing through the Old Woman Mountains, which separates this unit from the Twentynine Palms Unit, and its northwest boundary is

along the Providence and New York Mountains. These boundaries are shown on Plate 1. The Lanfair Valley Unit encompasses an area of about 3,200 square miles.

The northeast section forms a large surface drainage area which is exceeded in size only by the Mojave River Valley in the area of investigation. The divide begins at the crest of the Providence and New York Mountains and contains the large land areas of Lanfair and Fenner Valleys. The drainage terminates at Bristol Dry Lake at the lower end. The ground surface elevation of Lanfair Valley is about 4,000 feet, which is greater than other desert basins within the investigational area. Even with this large surface drainage there are no perennial streams. The southern portion of the Lanfair Valley Unit contains several basins or valleys most of which are isolated with little or no development.

In the years immediately following the turn of the century, many settlers took up homesteads in Lanfair Valley and also, to a limited extent, in Fenner Valley. Many attempts were made to raise crops by dry farming. Although Lanfair Valley enjoys somewhat more rainfall than is common in the lower desert areas, these ventures failed for lack of sufficient water. A few wells were drilled but pumping lifts were too great and yields too small to sustain irrigated agriculture. By 1920, attempts to farm the land ceased and the only remaining agricultural activity was cattle grazing, which has continued to the present time.

Mining in the Lanfair Valley Unit is essentially the only industrial activity. Many minerals and chemical deposits are known to exist although, as in most of the other desert areas, these operations are intermittent depending on market conditions. No mines of appreciable size operate on a continuous basis in the area.

CHAPTER III. LAND USE

The nature, location and areal extent of current land use within the study area was determined by a compilation of data from two surveys conducted by the Department of Water Resources during the summers of 1957 and 1958 and from a survey of Imperial Valley conducted by the Imperial Irrigation District during March of 1959. In addition, supplemental surveys were conducted by the department in Coachella, Borrego and Palo Verde Valleys during 1958-59 at intervals of approximately three months. These supplemental surveys were carried out for the purpose of evaluating agricultural practices in areas where climatic conditions ordinarily permit a year-round growing season. Supplemental surveys were also conducted by the Imperial Irrigation District and appear in this report as Appendix B. A discussion of survey methods and procedures, and the results of these surveys are summarized in this chapter.

Methods and Procedures

In order to relate present land use data to historical data, this investigation employed survey procedures similar to those used in the 1950 survey, which is described in Bulletin No. 2. Departmental survey teams delineated acreages of the various land use classes in the field on either vertical aerial photographs, or on United States Geological Survey quadrangle maps where photographic coverage was not available. In the office, field delineations were transferred by projection to acetate overlays of United States Geological Survey quadrangle maps of 1:24000 scale. These maps served as area control maps, ensuring the accuracy of the succeeding processes while the acetate overlays served as masters for

reproducing land use delineations on vellum prints. The individual areas of land use classes were cut from the vellum prints and weighed, and by machine computing processes these weights were converted into total acreages of individual land use classes. Because of the control developed as the result of the use of quadrangles, the overall results can be considered accurate to within about plus or minus three percent. However, the results for individual areas should not be considered to have an accuracy of more than plus or minus five percent.

As discussed earlier, all agricultural land use development within the Imperial Irrigation District was surveyed and recorded by personnel of that district. The results of their survey were adjusted to conform with the department's land use categories and incorporated into the summary tables in this chapter.

For purposes of a critical hydrologic analysis it would be desirable to determine and compile the types of land use, either undeveloped or developed, for the entire area of the hydrographic unit, permitting a comprehensive analysis and evaluation of the various levels of water use for the entire area. However, such a complete compilation is time consuming and expensive, and it is the usual practice to curtail the activities in those areas which are not underlain by water-bearing material only to mapping those classes of land use requiring applied water. However, even this was considered inappropriate for the present study since cultural development in the southeastern desert area has been of a limited localized nature. Therefore, detailed land use surveys, where all classes of land use are delineated, were conducted only in those areas of intensive cultural development, such as the Antelope, Mojave River, Coachella,

Imperial, Yuma, and Palo Verde Valleys. In other areas of lesser development, only those classes of land use requiring water service were mapped. Hydrologic studies in these lesser developed areas were considered to be less critical since it is generally assumed that precipitation on most of these undeveloped portions would be consumed by native vegetation or evaporated.

Categories of Land Use

For purposes of analysis and presentation, the various types of land use in water service areas were grouped in two major categories: Urban and Suburban, and Irrigated Agriculture. These two major categories were then subdivided into the several classes of land use, based on water requirements. The objective of this classification was to group the various types of land use into classes, each of which were considered to require similar amounts of water.

The two major categories and the specific classes of land use included in each of these categories are as follows:

Water Service Area

Urban and Suburban

Residential	Single and multiple family houses and apartments, rest homes, trailer parks, and residential subdivisions under construction at time of survey.
Recreational residential	Weekend and summer home tracts within a primarily recreational area.
Commercial	All classes of commercial enterprises, including strip commercial and downtown commercial areas, schools, and hospitals.
Industrial	All classes of industrial land use involving manufacturing processing, and packaging, but excluding extractive industries (oil, sand, and gravel), air fields, storage, distribution and transportation facilities.

Unsegregated urban and suburban area	Dairies, farmsteads, livestock ranches, parks, cemeteries, and golf courses.
Included nonwater-service area	Oil fields, tank farms, vacant lots, quarries, gravel pits, warehouses and storage yards, railroads, public streets, and landing strips of air fields.

Irrigated Agriculture

Alfalfa	Hay, seed, and pasture.
Pasture	Irrigated grasses and legumes other than alfalfa used for livestock forage.
Citrus and subtropical . .	Oranges, lemons, grapefruit, tangerines, avocados, dates, and olives.
Truck crops	Vegetables of all varieties, melons, flower seed, and nursery crops.
Field crops	Cotton, sorghums, flax, sugar beets, and field corn.
Deciduous fruits and nuts .	All varieties of deciduous fruits and nuts.
Small grain	Barley, wheat and oats.
Vineyards	All varieties.
Included nonwater-service area	Public highways and roads, farm access roads, canals, drainage ditches, and other inclusions not devoted to crop production, including idle, and abandoned lands.

The classes of land use given here are similar to those used in Bulletin No. 2, except that schools, previously included in "unsegregated urban and suburban area", are classified herein as "commercial"; in addition,

parks, golf courses, and cemeteries, classified as "irrigated pasture" in 1950 are included under "unsegregated urban and suburban area" in this report.

In delineating land use classes in the field, no attempt was made to exclude such items as streets, roads, railroads, power line right-of-ways, and other essentially nonwater-using lands occurring within the surveyed areas. Instead, these land uses were classified as "included nonwater service areas", and were extracted from overall land use totals by applying to each major land use class a percentage value appropriate for that class. The major classes of land use and appropriate reduction factors are presented in Table 5. The net acreage values used in the tables summarizing land use represent the gross acreage values minus those portions of the gross values which have been deducted for these "included nonwater service areas."

TABLE 5

FACTORS FOR REDUCTION OF GROSS AREAS TO NET WATER SERVICE AREAS

Land use	:Percent deducted :from gross area
Residential	25
Commercial	35
Industrial manufacturing	25
Parks, cemeteries, and golf courses	15
Farmsteads, feedlots, dairies	10
Irrigated agriculture	5

Many areas located within military reservations throughout the area of investigation were restricted to entry and thus could not be mapped in the field. Those portions of military reservations which were mapped indicated that the land uses therein were primarily nonwater-using developments, such as paved landing areas, storage depots, or gunnery ranges. Consequently, the land use occurring within such military reservations is not included in the summary tables.

Results of Land Use Survey

The results of the land use survey indicate that about 878,000 acres of land in the southeastern desert area required water service in 1958. As shown on Table 6, which summarizes land use on the basis of hydrographic units, about 801,000 acres of this total were included in the irrigated agriculture classes, while 77,000 acres were in the urban and suburban classes. Table 6 also shows that about 823,000 acres or approximately 94 percent of the total lands requiring water service are located within four hydrographic units: the Antelope Valley, Coachella Valley, Imperial Valley, and Colorado River units. Table 7 summarizes land use by counties in the area of investigation.

Details of the patterns of land use in the survey area are given on Plates 3A, 3B, 3C, and 3D, "Present Land Use". Although the acreages of nonwater service areas within urban and suburban and irrigated agriculture areas are shown individually on Tables 6 and 7, they were not differentiated on the plates.

Water service to about 728,000 acres, or approximately 83 percent of all lands within the area of investigation, is provided by four major water agencies; the land use in the service areas of these four agencies

BLE 6 TABLE 6

THE SOUTHEASTERN DESERT AREA IN 1958

acres

Hydrographic units						
tynine: Coachella: Salton : Imperial : Colorado : Lanfair :						
alms : Valley : Sea : Valley : River : Valley : Totals						
,340	5,840	300	3,100	1,070	70	17,050
,240	2,850	230	0	60	0	14,310
140	970	40	680	240	30	3,630
0	80	10	580	60	0	920
210	1,680	110	12,310	980	50	17,390
,930	11,420	690	16,670	2,410	150	53,300
,830	4,640	350	7,720	2,150	180	23,960
,760	16,060	1,040	24,390	4,560	330	77,260
,150	5,900	1,610	135,860	25,870	0	214,680
600	2,130	470	2,500	8,860	0	22,010
0	13,860	90	1,760	530	0	16,240
10	8,730	420	24,790	4,250	0	39,640
0	7,980	380	100,310	26,130	0	140,940
0	350	60	100	30	0	2,170
350	2,850	580	110,790	6,440	0	137,880
0	12,330	2,000	80	20	0	14,440
,110	54,130	5,610	376,190	72,130	0	588,000
0	4,810	110	89,530	16,580	0	118,980
230	8,750	1,350	66,680	12,430	0	93,920
,340	67,690	7,070	532,400	101,140	0	800,900
,100	83,750	8,110	556,790	105,700	330	878,160

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TABLE 6

LAND USE IN HYDROGRAPHIC UNITS OF THE SOUTHEASTERN DESERT AREA IN 1958

In acres

Nature and class of land use	Hydrographic units									
	Death Valley	Mojave River	Antelope Valley	Twentynine Palms	Coachella Valley	Salton Sea	Imperial Valley	Colorado River	Lanfair Valley	Totals
WATER SERVICE AREA										
Urban and Suburban										
Residential	730	1,350	3,250	1,340	5,840	300	3,100	1,070	70	17,050
Recreational residential	0	30	900	10,240	2,850	230	0	60	0	14,310
Commercial	130	510	890	140	970	40	680	240	30	3,630
Industrial	100	40	50	0	80	10	580	60	0	920
Unsegregated urban and suburban area	100	450	1,500	210	1,680	110	12,310	980	50	17,390
Subtotals	1,060	2,380	6,590	11,930	11,420	690	16,670	2,410	150	53,300
Included Nonwater-Service Area	1,140	1,760	4,190	1,830	4,640	350	7,720	2,150	180	23,960
Gross Urban and Suburban Area	2,200	4,140	10,780	13,760	16,060	1,040	24,390	4,560	330	77,260
Irrigated Agriculture										
Alfalfa	4,820	7,060	32,410	1,150	5,900	1,610	135,860	25,870	0	214,680
Pasture	370	1,960	5,120	600	2,130	470	2,500	8,860	0	22,010
Citrus and subtropical	0	0	0	0	13,860	90	1,760	530	0	16,240
Truck crops	20	130	1,290	10	8,730	420	24;790	4,250	0	39,640
Field crops	2,640	1,290	2,210	0	7,980	380	100,310	26,130	0	140,940
Deciduous fruits and nuts	0	90	1,540	0	350	60	100	30	0	2,170
Small grains	1,990	310	14,570	350	2,850	580	110,790	6,440	0	137,880
Vineyards	0	10	0	0	12,330	2,000	80	20	0	14,440
Subtotals	9,840	10,850	57,140	2,110	54,130	5,610	376,190	72,130	0	588,000
Fallow	1,400	1,030	5,520	0	4,810	110	89,530	16,580	0	118,980
Included Nonwater-Service Area	560	580	3,340	230	8,750	1,350	66,680	12,430	0	93,920
Gross Irrigated Agriculture	11,800	12,460	66,000	2,340	67,690	7,070	532,400	101,140	0	800,900
GROSS WATER SERVICE AREA	14,000	16,600	76,780	16,100	83,750	8,110	556,790	105,700	330	878,160

TABLE 7

LAND USE IN COUNTIES OF THE
SOUTHEASTERN DESERT AREA IN 1958

Area in acres

Nature and class of land use	Kern	Los Angeles	San Bernardino	Riverside	Imperial	San Diego	Total
WATER SERVICE AREA							
Urban and Suburban							
Residential	780	2,910	3,510	6,390	3,180	280	17,050
Recreational residential	0	140	11,300	2,640	0	230	14,310
Commercial	220	770	750	1,130	730	30	3,630
Industrial	50	10	140	140	570	10	920
Unsegregated urban and suburban area	180	1,390	780	2,530	12,420	90	17,390
Subtotals	1,230	5,220	16,480	12,830	16,900	640	53,300
Included Nonwater-Service Area	2,240	2,780	4,560	6,170	7,950	260	23,960
Gross Urban and Suburban Area	3,470	8,000	21,040	19,000	24,850	900	77,260
Irrigated Agriculture							
Alfalfa	5,860	29,820	9,850	26,720	140,820	1,610	214,680
Pasture	760	4,570	3,060	9,400	3,750	470	22,010
Citrus and subtropical	0	0	100	14,010	2,040	90	16,240
Truck crops	300	1,010	150	12,650	25,110	420	39,640
Field crops	3,830	650	1,710	29,170	105,200	380	140,940
Deciduous fruit and nuts	10	1,530	90	350	130	60	2,170
Small grains	3,360	13,080	950	7,190	112,720	580	137,880
Vineyards	0	0	10	12,340	100	1,990	14,440
Subtotals	14,120	50,660	15,920	111,830	389,870	5,600	588,000
Fallow	2,910	3,920	1,180	19,360	91,540	70	118,980
Included Nonwater-Service Area	1,000	2,750	1,060	18,830	68,890	1,390	93,920)
Gross Irrigated Agriculture	18,030	57,330	18,160	150,020	550,300	7,060	800,900
GROSS WATER SERVICE AREA	21,500	65,330	39,200	169,020	575,150	7,960	878,160

is shown on Table 8. With the exception of approximately 19,800 acres in the Coachella County Water District which receives water from wells, the entire service area of these four water agencies is dependent upon water from the Colorado River.

Change in Land Use

There were major increases in the area requiring water service between 1950 and 1958 in the area of investigation. As shown on Table 9, the gross urban and suburban water service areas increased from about 27,000 acres in 1950 to 77,000 acres in 1958, while the gross agricultural water service areas increased from about 643,000 acres in 1950 to 801,000 acres in 1958. Both irrigated agriculture and urban and suburban areas expanded into previously undeveloped land areas, and the gross area requiring water service increased from 670,000 acres in 1950 to 878,000 acres in 1958, an overall increase of about 31 percent.

There was some decline in irrigated acreages in Antelope Valley and Mojave River Valley units. This decline and other changes are delineated on Plate 4, "Change in Land Use, Antelope Valley and Vicinity, 1950 to 1957," and Plate 5, "Change in Land Use, Coachella and Palo Verde Valleys and Vicinities, 1950 to 1958." Changes in land use occurring in each hydrographic unit are discussed in the following sections.

Death Valley Unit (6-10)

The gross water service area in the Death Valley Unit increased about 2,500 acres, or approximately 22 percent, between 1950 and 1958. Approximately 1,000 acres of this total expansion were in urban and suburban development, and 1,500 acres were irrigated agriculture.

LAND USE IN SERVICE AREAS OF MAJOR WATER AGENCIES OF
THE SOUTHEASTERN DESERT AREA IN 1958

Area in acres

Nature and class of land use	Coachella Valley County Water District	Imperial Irrigation District	Palo Verde Irrigation District	Bard Irrigation District	Total
WATER SERVICE AREA					
Urban and Suburban					
Residential	2,270	3,100	510	40	5,920
Recreational residential	10	0	0	0	10
Commercial	470	680	130	20	1,300
Industrial	60	580	60	0	700
Unsegregated urban and suburban area	1,310	12,310	810	100	14,530
Subtotals	4,120	16,670	1,510	160	22,460
Included Nonwater-Service Area	2,320	7,720	860	90	10,990
Gross Urban and Suburban Area	6,440	24,390	2,370	250	33,450
Irrigated Agriculture					
Alfalfa	5,700	135,860	20,360	3,510	165,430
Pasture	1,920	2,500	7,380	960	12,760
Citrus and subtropical	13,730	1,760	10	280	15,780
Truck crops	8,690	24,790	4,050	110	37,640
Field crops	7,970	100,310	21,430	3,780	133,490
Deciduous fruit and nuts	60	100	10	30	200
Small grains	2,730	110,790	4,330	1,790	119,640
Vineyards	12,300	80	0	20	12,400
Subtotals	53,100	376,190	57,570	10,480	497,340
Fallow	4,980	89,530	15,090	1,080	110,680
Included Nonwater-Service Area	8,260	66,680	10,060	1,420	86,420
Gross Irrigated Agriculture	66,340	532,400	82,720	12,980	694,440
GROSS WATER SERVICE AREA	72,780	556,790	85,090	13,230	727,890

Mojave River Unit (6-11)

The Mojave River Unit experienced only a minor change in gross area requiring water service, increasing from 15,800 to 16,600 acres between 1950 and 1957. Although the urban and suburban area increased substantially from 1,900 acres in 1950 to 4,100 acres in 1957, or 116 percent, the irrigated agricultural area decreased 10 percent from 13,900 acres to 12,500 acres in the same period. The largest decreases in irrigated acreage were alfalfa and truck crops.

Antelope Valley Unit (6-12)

The gross urban and suburban area requiring water service in the Antelope Valley Unit increased from about 2,000 acres in 1950 to 10,800 acres in 1957, or nearly five and one-half times, while the irrigated agricultural acreage decreased from 72,700 acres to 66,000 acres, or nine percent. The largest decrease in irrigated agricultural acreage occurred in alfalfa, which dropped from 62,100 acres in 1950 to 32,400 acres in 1957. The acreage of deciduous fruits and nuts also decreased, but acreages of small grains, field crops, and truck crops increased substantially.

Twentynine Palms Unit (7-1)

A large increase in the gross urban and suburban area occurred in the Twentynine Palms Unit. In 1950, about 800 acres were subject to this land use, but by 1958 this acreage had increased to 13,800 acres, or a little more than 17 times. However, a large portion of this expansion (10,200 acres) was classified in the recreational residential category. This category consists of small buildings occupied essentially during vacations or weekends on large (2.5 acres or more) lots. Irrigated agriculture increased only slightly during the same period, going from 2,000 acres to 2,300 acres, an increase of about 15 percent.

Coachella Valley Unit (7-2)

The Coachella Valley Unit experienced an increase of 47,800 acres in gross water service area between 1950 and 1958. Urban and suburban acreage increased from 4,900 acres in 1950 to 16,100 acres in 1958, and of this 11,200 acre increase, 2,800 acres were in recreational residential development. The gross irrigated agricultural acreage increased from 31,100 acres in 1950 to 67,700 acres in 1958, a gain of 36,600 acres, or about 118 percent. All categories of crops showed substantial acreage gains with the exception of deciduous fruits and nuts. Approximately 60,200 acres of this total irrigated area are served by water from the Colorado River, but the remaining 7,500 acres are dependent entirely on ground water for water supplies.

Salton Sea Unit (7-3)

The gross water service area in the Salton Sea Unit showed an increase of 5,300 acres during the 8-year period. Urban and suburban acreage increased from 300 acres to 1,000 acres, or 3.3 times with approximately 200 acres of this 700 acre increase occurring in recreational type residential development. The irrigated agricultural acreage increased from 2,500 acres in 1950 to 7,100 acres in 1958, with alfalfa acreage undergoing the greatest increase.

Imperial Valley Unit (7-4)

Irrigated agriculture in the Imperial Valley Unit expanded from a net area of 363,800 acres in March 1952 to 376,200 acres in March 1959, a 3 percent increase. During this period, the acreage planted in alfalfa decreased substantially while acreages of field crops and small grains

increased. In contrast to this small increase, the gross urban and suburban area increased from 12,200 acres to 24,400 acres, or 100 percent.

Colorado River Unit (7-5)

A large increase in irrigated agricultural acreage occurred in the Colorado River Unit; the 65,200 acres in 1950 had been expanded to 101,100 acres by 1958, a growth of about 55 percent. Field crops and pasture both increased in acreage, but alfalfa acreage decreased somewhat. During the 8-year period, the acreage increase in urban and suburban development amounted to only about 18 percent, with growth from 3,900 acres in 1950 to 4,600 acres in 1958.

Lanfair Valley Unit (7-6)

Significant changes have not occurred in the Lanfair Valley Unit between 1950 and 1958. The gross urban and suburban water service area remained at about 300 acres, and irrigated agriculture does not exist in this unit.

Supplemental Resurveys of Multiple Cropped Areas

In the southern portion of the investigational area, the short mild winters make the raising of crops possible on a year-round basis. In these intensively farmed areas, field mapping conducted during the summer season characteristically reveals large acreages of land in a fallow or between-crop condition. Under normal cropping practices, it was assumed that a large portion of this fallow land would be subsequently planted at some point during the study period. The net water use of fallow lands is negligible and therefore estimates of net water use based only on data

TABLE 9

olorado River		Lanfair Valley		Totals	
1950	1958	1950	1958	1950	1958
3,900	4,560	300	330	27,480	77,260
0,800	25,870	0	0	282,880	214,680
3,500	8,860	0	0	10,020	22,010
200	530	0	0	10,310	16,240
0,100	4,250	0	0	53,150	39,640
8,200	26,130	0	0	91,410	140,940
0	30	0	0	6,390	2,170
0,900	6,440	0	0	93,010	137,880
0	20	0	0	9,880	14,440
3,700	72,130	0	0	557,050	588,000
[c]	16,580	0	0	81,120	118,980
1,500	12,430	0	0	4,600	93,920
5,200	101,140	0	0	642,770	800,900
9,100	105,700	300	330	670,250	878,160

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TABLE 9

LAND USE COMPARISON IN HYDROGRAPHIC UNITS OF THE
SOUTHEASTERN DESERT AREA BETWEEN 1950 AND 1958

In acres

Nature and class of land use	Hydrographic Units																			
	Death Valley		Mojave River		Antelope Valley		Twentynine Palms		Coachella Valley		Salton Sea		Imperial Valley		Colorado River		Lanfair Valley		Totals	
	1950	1958	1950	1957	1950	1957	1950	1958	1950	1958	1950	1958	1950	1958	1950	1958	1950	1958	1950	1958
WATER SERVICE AREA																				
Gross Urban and Suburban Area[a]	1,180	2,200	1,900	4,140	2,000	10,780	800	13,760	4,900	16,060	300	1,040	12,200	24,390	3,900	4,560	300	330	27,480	77,260
Irrigated Agriculture																				
Alfalfa	5,700	4,820	7,500	7,060	62,100	32,410	1,600	1,150	2,400	5,900	500	1,610	172,280	135,860	30,800	25,870	0	0	282,880	214,680
Pasture	0	370	1,700	1,960	100	5,120	400	600	1,500	2,130	100	470	2,720	2,500	3,500	8,860	0	0	10,020	22,010
Citrus and subtropical	0	0	0	0	0	0	0	0	8,200	13,860	100	90	1,810	1,760	200	530	0	0	10,310	16,240
Truck crops	900	20	2,100	130	100	1,290	0	10	4,100	8,730	100	420	35,750	24,790	10,100	4,250	0	0	53,150	39,640
Field crops	1,600	2,640	0	1,290	200	2,210	0	0	5,100	7,980	300	380	76,010	100,310	8,200	26,130	0	0	91,410	140,940
Deciduous fruits and nuts	0	0	400	90	4,500	1,540	0	0	1,400	350	0	60	90	100	0	30	0	0	6,390	2,170
Small grains	1,800	1,990	1,900	310	4,200	14,570	0	350	400	2,850	0	580	73,810	110,790	10,900	6,440	0	0	93,010	137,880
Vineyards	0	0	0	10	0	0	0	0	7,100	12,330	1,400	2,000	1,380	80	0	20	0	0	9,880	14,440
Subtotals	10,000	9,840	13,600	10,850	71,200	57,140	2,000	2,110	30,200	54,130	2,500	5,610	363,850	376,190	63,700	72,130	0	0	557,050	588,000
Fallow	[b]	1,400	[b]	1,030	[b]	5,520	[b]	0	[b]	4,810	[b]	110	81,120	89,530	[c]	16,580	0	0	81,120	118,980
Included Nonwater-Service Area	300	560	300	580	1,500	3,340	0	230	900	8,750	100	1,350	[c]	66,680	1,500	12,430	0	0	4,600	93,920
Gross Irrigated Agriculture	10,300	11,800	13,900	12,460	72,700	66,000	2,000	2,340	31,100	67,690	2,600	7,070	444,970	532,400	65,200	101,140	0	0	642,770	800,900
GROSS WATER SERVICE AREA	11,480	14,000	15,800	16,600	74,700	76,780	2,800	16,100	36,000	83,750	2,900	8,110	457,170	556,790	69,100	105,700	300	330	670,250	878,160

a. 1958 classes grouped to correspond with 1950 classes.
b. Acreage of fallow lands included in appropriate class of irrigated agriculture in 1950 survey.
c. Value not available.

collected during the main survey in June 1958 would not be truly representative of conditions in the study area.

Following the main survey in June 1958, three supplemental resurveys were conducted in certain predetermined areas in order to determine the subsequent use of this fallow acreage. These resurveys were made during November 1958 and February and May 1959 in the Coachella, Borrego, and Palo Verde Valleys.

During each of the resurveys, the nature and areal extent of crops planted in this fallow acreage, subsequent to the June 1958 survey, were determined. Field mapping during these resurveys indicated that portions of the fallow acreages were planted, then subsequently replanted to different crops or allowed to revert to fallow conditions. However, during the analysis of the resurvey data from which the percentages shown in Table 10 were derived, these factors were not considered. Instead, the nature and areal extent of crops were considered on a cumulative basis.

Under this method, the first crop mapped on a previously fallow parcel was used as the basis for deriving unit use values, and removed that parcel from the fallow classification for the remainder of the study period. It should be pointed out here that the increased use of water resulting from multiple cropping practices, including fallow periods between crops, was considered in estimating average unit values of water use for truck crops.

Analysis of the data from the resurveys indicates that in the Coachella, Borrego, and Palo Verde Valleys, 19 percent, 84 percent, and 8 percent, respectively, of the total area indicated as fallow during the June survey remained fallow throughout the succeeding resurveys. The

remaining land, which had been mapped fallow in June 1958 in these valleys, was found during the subsequent resurveys to be planted to the various crops in the percentages shown on Table 10.

TABLE 10

DISPOSITION DURING RESURVEY PERIOD OF
ACREAGE FOUND FALLOW IN SUMMER 1958
(In percent of June fallow acreage)

Nature of land use	Area Resurveyed		
	Coachella Valley	Borrego Valley	Palo Verde Valley
Area remaining fallow all year	19	84	8
Area planted and crop			
Alfalfa	6	0	23
Truck crops	45	14	37
Field crops	19	0	10
Small grains	11	2	22
Total	100	100	100

The values given in Table 10 were used as the basis for distributing the fallow acreages determined from the June, 1958, survey into the appropriate crops for determining water requirements. However, the acreage values presented in Tables 6, 7, 8, and 9, and in Appendixes C and D, which show the land use at the time of the principal survey, have not been modified to reflect these percentage increases. The values for Palo Verde Valley were used for the entire Colorado River hydrographic unit. In the Salton Sea hydrographic unit the only fallow acreage mapped occurred in Borrego Valley.

Fallow lands are also found in the Death Valley, Mojave River and Antelope Valley hydrographic units, as indicated on Table 9 and other

summary tables. It is recognized that portions of this acreage may be used to produce irrigated crops during the fall and winter months, however, lower temperatures generally prevail in these higher desert areas and they are not usually considered suitable for year-round cultivation. Therefore, resurveys were not conducted in these units and no evaluation was made of the extent that crops were grown on this fallow acreage.

As mentioned previously, supplemental land use surveys were also conducted by personnel of the Imperial Irrigation District, for land use within that district. Although the results of these supplemental surveys are presented in Appendix B, these data did not require further evaluation or discussion since the methods used in developing net water use, which are described in the next chapter, did not require their use.

Courtesy Spence Air Photos

All American Canal at the Coachella Canal Turnout

CHAPTER IV. WATER USE

The land areas occupied by various types of water-using developments in the southeastern desert area were described in Chapter III. Since this land use was classified on the basis of water requirements, it is possible to apply appropriate unit values of water use to estimate the 1958 levels of water use in this area. This level of use must be known so that adequate programs of water resource development can be planned and implemented to meet the needs of the future growth of the area.

This chapter defines what is meant by water use and presents the methods used in estimating water use, gives the unit values of water use, and presents estimates of 1958 water requirements.

Definition of Water Use

The term water use is employed in the broadest sense to include all uses of water by nature under native conditions and by man in his modifications of those natural conditions. It implies the application of water to any one, or all, of innumerable kinds of uses, both consumptive and nonconsumptive.

Consumptive use includes the water from any source utilized in the process of vegetative growth, such as transpiration and the building of plant tissue, and the water evaporated from the soil around the plant and foliage, as well as from water surfaces. It also includes the water consumed or evaporated by urban and nonvegetative types of land use.

In addition to the consumptive use of water as defined above, there may be irrecoverable losses incidental to such use. These

irrecoverable losses include such items as deterioration in water quality to the point where the water is unsuitable for reuse, disposal or seepage of the unconsumed water to bodies of unsuitable quality including the Salton Sea, and disposal or seepage of the unconsumed water in such a manner as to be uneconomical of recapture for use.

The water for consumptive use is obtained from two general sources: natural sources including direct precipitation and surface runoff, and, as a special case, from a high ground water table; and man-developed sources, that is, water applied through the activities of man. Water furnished from this latter source is termed "applied water."

Man applies water to satisfy the consumptive use needs in excess of that supplied from natural sources. However, as a practical matter, the quantity of water applied is usually in excess of the consumptive use of applied water, and that portion of the water applied to any use that is not consumed or irrecoverably lost remains part of the water supply.

In evaluating the overall needs for water in an area, it is necessary to determine the portion of the applied water that is consumptively used. That portion of the applied water that is consumptively used and irrecoverably lost is known as the "net water use." The difference between the applied water and the net water use is the amount of applied water that is subject to reuse as a part of the common supply.

Methods of Estimating Water Use

It follows from the previous discussion that in areas where none of the applied water becomes available for reuse, it is possible to determine the net water use by measuring the total water applied. On

the other hand, in areas where a portion of the applied water becomes available for reuse, present technology is generally inadequate to measure this volume of return flow of reusable water. The net water use in these areas must be determined in another manner, therefore an indirect method is used.

Using the indirect method commonly employed, estimates of net water use are obtained by multiplying the areas of the various classes of water using developments by appropriate average values of unit water use. These unit values of water use reflect average conditions of precipitation and the normal practices associated with urban water distribution and irrigated agriculture. Variations from normal or average in these factors during the specific year that a land use survey is conducted may result in a difference between the estimated and actual water use during that year. Despite this possibility, it is considered that the procedures used in this survey are adequate, and that the figures on current levels of water use are reasonable. Furthermore, it is believed that these estimates of net water use are sufficiently sound to permit their use in determining the adequacy of presently available water supplies and for planning for such additional supplies as will be necessary to meet current or expected future deficiencies.

Unit Values of Water Use

A complete discussion of the techniques employed in the derivation of unit values of water use is contained in Bulletin No. 2; consequently, only a very general discussion of those techniques is undertaken here. The unit water use values are divided into the general categories of urban and suburban, and irrigated agriculture use values.

Urban and Suburban Water Use Values

A review of the unit values of urban and suburban water use developed for Bulletin No. 2 indicated that, in general, the values derived in 1950 were still the best estimates available, and these values were used in the derivation of the 1958 levels of net water use on urban and suburban lands that are shown on Table 11.

TABLE 11

ESTIMATED MEAN SEASONAL UNIT VALUES OF NET WATER USE ON URBAN AND SUBURBAN LANDS, SOUTHEASTERN DESERT AREA

(In feet of depth per unit of area)

Hydrographic unit	Net water use
Death Valley	0.3
Mojave River	1.2
Antelope Valley	1.0
Twentynine Palms	1.2
Coachella Valley	2.3
Salton Sea	1.6
Imperial Valley	1.7
Colorado River	1.5
Lanfair Valley	0.3

Mean seasonal unit values of water use on urban and suburban lands in the desert areas of California were estimated for Bulletin No. 2 from records of measured water deliveries obtained from private and public service agencies. In areas where sewage disposed from urban and suburban areas returns to the ground water body, unit values of water use were computed by deducting the estimated quantity of such return from the

amount of water delivered to the area. In other areas where sewage is discharged to the point of final disposal without opportunity for reuse, the gross delivery was taken as a measure of the net water use.

In the Coachella Valley, particularly in the vicinity of Palm Springs, Indio and Desert Hot Springs, much land has been developed to a "spa" or high grade recreational use, and a review of Bulletin No. 2 indicated that the unit value of water use for this type of development should be revised upward because of increased water use. Accordingly, the unit value for this valley was increased from 1.7 to 2.3 acre-feet per acre, based on an analysis of water delivery values which were obtained from water service agencies in the valley, and other factors of water use and disposal previously described.

It will be noted that the tables of land use presented in Chapter III differentiated between urban residential and the recreational residential classes. Within the area encompassed by this investigation, this latter class of land use generally consisted of small dwellings on 2-1/2 to 5-acre tracts, usually occupied less than 25 percent of the time. A study was made to evaluate the water requirements of this class and it was found that water supplies were usually obtained from agencies which truck water to the dwellings at a cost of about .75 cents a gallon, or that water was carried in by the recreationists, either from their permanent dwellings or from nearby service stations. Such supplies were used for drinking, cooking, and essential washing purposes only. The total seasonal volume of water used was determined to be very small (on the order of 0.01 acre-feet/acre) and was, therefore, neglected in the determination of water requirements in this report.

Irrigated Agriculture Water Use Values

The unit value of consumptive use of applied water for each of the irrigated crop classes employed in Bulletin No. 2 was estimated by a modification of a method developed by Harry F. Blaney and Wayne D. Criddle of the United States Department of Agriculture. In the present investigation as in Bulletin No. 2, the increased use of water, resulting from multiple cropping practices in some localities, was considered in estimating average unit values of water use for truck crops. The values thus derived are presented in Table 12.

The values shown in Table 12 represent estimates of the average consumptive uses derived from applied water and from precipitation by the various types of irrigated agriculture. As pointed out before, in the derivation of the net water use for any given year the volume of applied water required is based on the assumption that the precipitation for the season is approximately equal to the long-time mean. However, as discussed earlier, the use of applied water in irrigated agriculture will actually be somewhat larger or smaller in individual years, varying inversely with the amount of rainfall. A similar effect also occurs in the instance of urban use, but variations of rainfall from year to year have a lesser effect upon the use of applied water on urban lands than on irrigated lands. However, it may be noted from the data presented in Table 12 that the beneficial value of precipitation is of minor magnitude for either use.

Net Water Use

Estimates of the level of net water use in the southeastern desert area under 1958 conditions of development were made by the direct

ALUES OF CONSUMPTIVE USE OF WATER
OUTHEASTERN DESERT AREA

h per unit of area)

Antelope Valley			Coachella Valley, Salton Sea, Imperial Valley, and Colorado River			Twentynine Palms and Lanfair Valley		
Consumptive use			Consumptive use			Consumptive use		
ied water	Precipitation	Total	Applied water	Precipitation	Total	Applied water	Precipitation	Total
0	0.6	3.6	4.2	0.3	4.5	2.9	0.3	3.2
8	0.6	3.4	5.0	0.3	5.3	2.7	0.3	3.0
-	--	--	4.0	0.3	4.3	--	--	--
-	--	--	6.0	0.3	6.3	--	--	--
4	0.6	2.0	3.0	0.3	3.3	1.5	0.3	1.8
-	--	--	3.0	0.3	3.3	--	--	--
0	0.6	2.6	2.5	0.3	2.8	--	--	--
5	0.6	2.1	2.4	0.3	2.7	--	--	--
2	0.6	2.8	2.3	0.3	2.6	2.2	0.3	2.5
8	0.6	1.4	1.8	0.3	2.1	1.0	0.3	1.3
4	0.6	3.0	3.6	0.3	3.9	--	--	--

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TABLE 12

ESTIMATED MEAN SEASONAL UNIT VALUES OF CONSUMPTIVE USE OF WATER
ON IRRIGATED LANDS, SOUTHEASTERN DESERT AREA

(In feet of depth per unit of area)

Type of land use	Death Valley			Mojave River			Antelope Valley			Coachella Valley, Salton Sea, Imperial Valley, and Colorado River			Twentynine Palms and Lanfair Valley		
	Consumptive use			Consumptive use			Consumptive use			Consumptive use			Consumptive use		
	Applied water	Precipitation	Total	Applied water	Precipitation	Total	Applied water	Precipitation	Total	Applied water	Precipitation	Total	Applied water	Precipitation	Total
Alfalfa	3.0	0.4	3.4	2.8	0.4	3.2	3.0	0.6	3.6	4.2	0.3	4.5	2.9	0.3	3.2
Pasture	2.8	0.4	3.2	2.7	0.4	3.1	2.8	0.6	3.4	5.0	0.3	5.3	2.7	0.3	3.0
Citrus	--	--	--	--	--	--	--	--	--	4.0	0.3	4.3	--	--	--
Dates	--	--	--	--	--	--	--	--	--	6.0	0.3	6.3	--	--	--
Truck crops	1.6	0.4	2.0	1.5	0.4	1.9	1.4	0.6	2.0	3.0	0.3	3.3	1.5	0.3	1.8
Cotton	--	--	--	--	--	--	--	--	--	3.0	0.3	3.3	--	--	--
Sugar beets	2.2	0.4	2.6	2.2	0.4	2.6	2.0	0.6	2.6	2.5	0.3	2.8	--	--	--
Miscellaneous field crops	1.6	0.4	2.0	--	--	2.1	1.5	0.6	2.1	2.4	0.3	2.7	--	--	--
Deciduous fruits and nuts	2.2	0.4	2.6	2.1	0.4	2.5	2.2	0.6	2.8	2.3	0.3	2.6	2.2	0.3	2.5
Small grains	1.1	0.4	1.5	0.9	0.4	1.3	0.8	0.6	1.4	1.8	0.3	2.1	1.0	0.3	1.3
Vineyards	2.4	0.4	2.8	2.3	0.4	2.7	2.4	0.6	3.0	3.6	0.3	3.9	--	--	--

and indirect methods discussed previously. For most of the area of investigation, net water use was estimated by applying mean seasonal unit values of consumptive use to the areas of each class of land use. This method was used for land that overlies or is tributary to free ground water basins, as in Borrego Valley, and for land which is irrigated by diversions from the Colorado River where the drainage returns to the river for reuse, as in Palo Verde Valley.

In those areas of the Imperial and Coachella Valleys which are serviced with Colorado River water, the quality of the applied water and the condition of the soil are such that sufficient water must be applied and carried away through subsurface drainage systems to maintain the salt concentration in the soil solution at limits required for plant growth. The drainage water, essentially unconsumed water of such poor mineral quality as to preclude its reuse, flows directly into the Salton Sea.

In such areas, the net water use was assumed to be equal to the applied water, and was based on measurements of quantities of diverted Colorado River water passing Drop 1 on the All American Canal for the Imperial Valley, and Mile Post 87 on the Coachella Canal for Coachella Valley.

The estimated levels of mean seasonal net water use in hydrographic units of the southeastern desert area for 1958 conditions are presented in Table 13; values estimated for 1950 conditions are also presented in this table for purposes of comparison.

As previously indicated, the unit values used to derive the levels of net water use shown on Table 13 represent the optimum applied water requirements for the various classes of land use under average

TABLE 13

ESTIMATED LEVELS OF NET WATER USE IN THE SOUTHEASTERN DESERT AREA FOR CONDITIONS OF DEVELOPMENT IN 1950 AND 1958*

Quantity in Acre-feet

Hydrographic unit	1950	1958	Difference
DEATH VALLEY UNIT			
Irrigated Lands	23,000	21,900	- 1,100
Urban - Suburban Areas	300	700	400
TOTALS	23,300	22,600	- 700
MOJAVE RIVER UNIT			
Irrigated Lands	31,400	27,700	- 3,700
Urban - Suburban Areas	2,600	4,900	2,300
TOTALS	34,000	32,600	- 1,400
ANTELOPE VALLEY UNIT			
Irrigated Lands	200,000	131,700	-68,300
Urban - Suburban Areas	2,200	9,500	7,300
TOTALS	202,200	141,200	-61,000
TWENTYNINE PALMS UNIT			
Irrigated Lands	5,600	5,300	- 300
Urban - Suburban Areas	1,200	3,500	2,300
TOTALS	6,800	8,800	2,000
COACHELLA VALLEY UNIT			
Irrigated Lands	119,000	356,600	237,600
Urban - Suburban Areas	7,500	30,500	23,000
TOTALS	126,500	387,100	260,600
SALTON SEA UNIT			
Irrigated Lands	8,900	20,600	11,700
Urban - Suburban Areas	300	1,100	800
TOTALS	9,200	21,700	12,500

ESTIMATED LEVELS OF NET WATER USE IN THE SOUTHEASTERN DESERT AREA FOR CONDITIONS OF DEVELOPMENT IN 1950 AND 1958*
(continued)

Quantity in Acre-feet

Hydrographic unit	1950	1958	Difference
IMPERIAL VALLEY UNIT			
Irrigated Lands	2,790,000	2,704,200	-85,800
Urban - Suburban Areas	15,400	26,700	11,300
TOTALS	2,805,400	2,730,900	-74,500
COLORADO RIVER UNIT			
Irrigated Lands	218,000	307,000	89,000
Urban - Suburban Areas	3,300	6,200	2,900
TOTALS	221,300	313,200	91,900
LANFAIR VALLEY UNIT			
Irrigated Lands	0	0	0
Urban - Suburban Areas	100	100	0
TOTALS	100	100	0
TOTAL INVESTIGATIONAL AREA			
Irrigated Lands	3,395,900	3,575,000	179,100
Urban - Suburban Areas	32,900	83,200	50,300
GRAND TOTALS	3,428,800	3,658,200	229,400

* Net water use is that portion of the applied water consumed and irrecoverably lost. It does not include the consumptive use of precipitation.

conditions of rainfall and climate. Available data from precipitation stations in the desert area indicate that precipitation over the area of investigation during 1950 was about 40 percent of normal, based on the

50-year period 1897-98 through 1946-47. On the other hand, during 1958 precipitation was about 150 percent of the 50-year normal figure.

The estimates of levels of net water use shown on Table 13 are, therefore, probably on the low side for 1950 and on the high side for 1958 as compared to actual water use in those years. However, the total depth of precipitation in desert areas is usually quite small even during wet years, thus the values given on Table 13 are considered to be reasonable estimates of changes in water use.

In general, the data presented in Table 13 indicate that changes in net water use reflect the changes in land use described in Chapter III. The overall net water use for the area increased about seven percent. Urban requirements increased substantially over 100 percent in nearly all areas, but at the present time they constitute only about two percent of the total net water requirements of the area. On the other hand, water requirements for agriculture decreased in a number of the basins which are primarily dependent on ground water supplies.

CHAPTER V. SUMMARY AND CONCLUSIONS

The results of the 1958 land and water use survey of the desert area of southeastern California, comparisons with the 1950 survey results, and conclusions drawn from this study are summarized in this chapter.

Summary

This investigation disclosed that in 1958 the following land uses and water requirements existed in the area of investigation:

1. A total of 878,000 acres, or about 4 percent of all lands within the surveyed area, had been developed for urban and suburban, and irrigated agriculture uses. This is an increase of about 34 percent over similar water-using developments that existed in 1950.
2. The estimated mean seasonal level of net water use by these water-using developments was about 3,658,000 acre-feet. This is an increase of about 229,000 acre-feet, or approximately 7 percent, over the 1950 estimated net water use level.
3. The gross urban and suburban area was slightly more than 77,000 acres, an increase of about 50,000 acres or 182 percent over that which existed in 1950. This increase was a direct result of an increase in population from 177,000 in 1950 to 350,300 in 1960. During the period 1950 to 1958, growth in urban and suburban areas occurred in all hydrographic units with the greatest increases taking place in the Antelope Valley and Coachella Valley Units.

4. The gross irrigated agricultural area was about 801,000 acres, an increase of about 25 percent over the 642,800 acres that existed in 1950. During the period 1950 to 1958, the greatest growth in irrigated agriculture occurred in the Coachella Valley, Imperial Valley, and Colorado River Units, increasing from about 529,000 acres to about 701,000 acres, or about 32 percent in these units, which are all largely dependent upon diversions from the Colorado River for their water supplies.

5. In the hydrographic units that are primarily dependent upon local ground water supplies, gross irrigated agriculture decreased from about 101,400 acres to about 99,700 acres, or about 2 percent, during the period 1950 to 1958.

Conclusions

Based on the results of this investigation, it is concluded that:

1. Cultural development has occurred and has been sustained in those portions of the desert area of southeastern California where an adequate supply of water is available.

2. Where cultural development in the desert area has been primarily dependent on local ground water supplies, irrigated agriculture has decreased as ground water levels have declined with a consequent increase in the cost for water. In the Antelope Valley Unit, for example, the irrigated agricultural development decreased from about 71,000 acres in 1950 to about 57,000 acres in 1958, and declining ground water levels in this unit have increased the cost of pumping

to the point where it is becoming uneconomical to grow certain of the relatively high water-using, low income crops.

3. Where cultural development has been based on imported water supplies, the irrigated agricultural areas have increased. In the portions of the Coachella Valley Unit served with Colorado River water, the irrigated agricultural area increased from about 21,000 acres in 1950 to about 60,000 acres in 1958, reflecting the availability and increasing use of Colorado River water which was first imported into this unit in 1949. This increase in the irrigated agricultural area that has occurred in this unit since the introduction of Colorado River water, points up the very rapid increases in cultural development that occur in desert areas when an adequate and reasonably economic water supply becomes available.

4. The population of the desert area increased about 98 percent during the period 1950 to 1960, rising from about 177,000 to about 350,300, and this increase is primarily responsible for the substantial increases in urban and suburban areas. This type of cultural development does not appear to be as responsive to declining water levels as irrigated agriculture since urban and suburban areas have continued to increase throughout the desert area, even in those hydrographic units where other types of land uses have decreased.

5. The land uses, water requirements, and growth trends established by this study should be monitored and re-evaluated by future land use surveys in order that the water supplies required to support such growth can be adequately planned and developed.

APPENDIX A

DEFINITION OF TERMS

APPENDIX A

DEFINITION OF TERMS

Annual - The 12-month period from January 1 of a given year through December 31 of the same year, sometimes termed the "calendar year."

Applied Water - Water delivered to a farmer's headgate, in the case of irrigation use, or to an individual's meter in the case of urban use, or its equivalent. It does not include direct precipitation.

Applied Water Requirement - The applied water needed to provide for all beneficial uses and for irrecoverable losses incidental to such uses. It excludes that portion of the requirement which is provided by rainfall.

Aquifer - A geologic formation or structure sufficiently permeable to yield an appreciable supply of water to wells or springs.

Average - An arithmetical average relating to a period other than a mean period.

Confined Ground Water - A body of ground water immediately overlain by material sufficiently impervious to sever free hydraulic connection with overlying water, and moving under pressure caused by the difference in head between the intake or forebay area and the discharge area of the confined water body.

Consumptive Use of Water - Water consumed by vegetative growth in transpiration and building plant tissue, and water evaporated from adjacent soil, from water surface, and from foliage. It also includes water similarly consumed and evaporated by urban and nonvegetative types of land use.

Free Ground Water - A body of ground water not immediately overlain by impervious materials.

Ground Water Overdraft - The rate of net extraction of water from a ground water basin in excess of safe ground water yield.

Irrigation Efficiency - The ratio of consumptive use of applied irrigation water to the total amount of water applied, expressed as a percentage.

Mean - An arithmetical average relating to a mean period.

Mean Period - A period chosen to represent conditions of water supply and climate over a long series of years. For purposes of the current investigation, the mean precipitation period embraces the 50 seasons from 1897-98 through 1946-47, and the mean runoff period, the 53 seasons from 1894-95 through 1946-47.

Net Water Use - "Net water use" is defined as that portion of the applied water which is consumptively utilized for beneficial purposes or irrecoverably lost. It does not include that portion of the applied water which is subject to possible reuse.

Present - Land use and water supply conditions prevailing during the 1957-58 season.

Safe Ground Water Yield - The average annual net amount of water that could be beneficially extracted from a ground water basin over an indefinitely long period of years, under a particular set of those physical conditions affecting supply to, and disposal from, the ground water basin, without causing a net lowering of ground water levels during the period.

Seasonal - Any 12-month period other than the calendar year.

Water Requirement - The water needed to provide for all beneficial uses and for all irrecoverable losses incidental to such uses.

Water Utilization - This includes all employments of water by nature or man, whether consumptive or nonconsumptive, as well as irrecoverable losses of water incidental to such employment, and is synonymous wit the term "water use."

APPENDIX B

IRRIGATED AGRICULTURAL LAND USE IN IMPERIAL IRRIGATION DISTRICT IN JUNE, SEPTEMBER, AND DECEMBER 1958; AND MARCH 1959

APPENDIX B

IRRIGATED AGRICULTURAL LAND USE IN IMPERIAL IRRIGATION DISTRICT IN JUNE, SEPTEMBER, AND DECEMBER 1958; AND MARCH 1959

In Acres

	June	September	December	March
Irrigated Agriculture				
Alfalfa	134,380	85,720	135,980	135,860
Pasture	4,920	7,120	4,580	2,500
Citrus and subtropical	1,460	1,970	1,830	1,760
Truck crops	12,460	14,410	55,300	24,790
Field crops	114,980	65,730	93,170	100,310
Deciduous fruits and nuts	80	100	100	100
Small grains	16,280	200	41,140	110,790
Vineyards	80	60	60	80
Subtotals	284,640	175,310	332,160	376,190
Fallow	181,080	290,410	133,560	89,530
TOTALS	465,720	465,720	465,720	465,720

APPENDIX C

LAND USE IN GROUND WATER BASINS OF THE LAHONTAN AREA OF SOUTHEASTERN CALIFORNIA, 1958

APPENDIX C

LAND USE IN GROUND WATER BASINS OF THE LAHONTAN AREA OF SOUTHEASTERN CALIFORNIA, 1958

In acres

Nature and class of land use	Broadwell Valley	Cronese Valley	Ivanpah Valley	Kelso Valley	Lower Mojave River Valley
WATER SERVICE AREA					
Urban and Suburban					
Residential	9	0	18	22	5
Recreational residential		0			
Commercial	8	2	3	4	3
Industrial	0	0	0	0	0
Unsegregated urban and suburban area	0	0	34	0	0
Subtotals	17	2	55	26	8
Included Nonwater-Service Area	10	2	47	44	21
Gross Urban and Suburban Area	27	4	102	70	29
Irrigated Agriculture					
Alfalfa	0	0	0	0	0
Pasture	0	0	0	0	0
Citrus and subtropical	0	0	0	0	0
Truck crops	0	0	0	0	0
Field crops	0	0	0	0	0
Deciduous fruits and nuts	0	0	0	0	0
Small grains	0	0	0	0	0
Vineyards	0	0	0	0	0
Subtotals	0	0	0	0	0
Fallow	0	0	0	0	0
Included Nonwater Service Area	0	0	0	0	0
Gross Irrigated Agriculture	0	0	0	0	0
GROSS WATER SERVICE AREA	27	4	102	70	29

LAND USE IN GROUND WATER BASINS OF THE LAHONTAN AREA OF SOUTHEASTERN CALIFORNIA, 1958
(continued)

In acres

Nature and class of land use	Searles Valley	Silver Lake Valley	Soda Lake Valley	Upper Kingston Valley
WATER SERVICE AREA				
Urban and Suburban				
Residential	260	2	22	4
Recreational residential			30	
Commercial	31	0	26	2
Industrial	92	7	0	0
Unsegregated urban and suburban area	5	7	12	0
Subtotals	388	16	90	6
Included Nonwater-Service Area	155	4	38	4
Gross Urban and Suburban Area	543	20	128	10
Irrigated Agriculture				
Alfalfa	0	0	0	0
Pasture	0	0	0	0
Citrus and subtropical	0	0	0	0
Truck crops	0	0	0	0
Field crops	0	0	0	0
Deciduous fruits and nuts	0	0	3	0
Small grains	0	0	0	0
Vineyards	0	0	0	0
Subtotals	0	0	3	0
Fallow	0	0	0	0
Included Nonwater-Service Area	0	0	6	0
Gross Irrigated Agriculture	0	0	9	0
GROSS WATER SERVICE AREA	543	20	137	10

APPENDIX D

LAND USE IN GROUND WATER BASINS OF THE COLORADO DESERT AREA, 1958

APPENDIX D

LAND USE IN GROUND WATER BASINS OF THE COLORADO DESERT AREA IN 1958

In acres

Nature and class of land use	Borrego Valley	Bristol Valley	Calzona Valley	Canebrake Valley	Chemehuvi Valley	Chuckawalla Valley	Coachella Valley
WATER SERVICE AREA							
Urban and Suburban							
Residential	130	11	93	0	14	62	5,680
Recreational residential	155	0	27	0	34	0	2,640
Commercial	4	26	6	0	1	14	970
Industrial	0	0	0	0	0	3	80
Unsegregated urban and suburban area	22	0	4	0	0	0	1,660
Subtotals	311	37	130	0	49	79	11,030
Included Nonwater-Service Area	160	825	71	0	6	90	4,570
Gross Urban and Suburban Area	471	862	201	0	55	169	15,600
Irrigated Agriculture							
Alfalfa	1,200	0	60	0	0	0	5,880
Pasture	125	0	0	6	0	0	2,130
Citrus and subtropical	86	0	80	0	0	0	13,290
Truck crops	300	0	4	0	0	0	8,480
Field crops	340	0	47	0	0	0	7,980
Deciduous fruits and nuts	4	0	0	0	0	0	350
Small grains	430	0	79	0	0	0	2,790
Vineyards	1,990	0	0	0	0	0	12,120
Subtotals	4,475	0	270	6	0	0	53,020
Fallow	80	0	4	0	0	0	4,810
Included Nonwater-Service Area	1,315	0	35	0	0	0	8,120
Gross Irrigated Agriculture	5,870	0	309	6	0	0	65,950
GROSS WATER SERVICE AREA	6,341	862	510	6	55	169	81,550

LAND USE IN GROUND WATER BASINS OF THE COLORADO DESERT AREA IN 1958
(continued)

In acres

Nature and class of land use	Copper Mountain Valley	Coyote Wells Valley	Dale Valley	Deadman Valley	East Salton Sea Valley	Fenner Valley	Imperial Valley
WATER SERVICE AREA							
Urban and Suburban							
Residential	300	0	4	0	45	49	3,100
Recreational residential	1,250	0	6,890	205	0	0	0
Commercial	14	1	0	0	6	20	680
Industrial	0	0	0	0	0	0	580
Unsegregated urban and suburban area	35	0	0	0	15	12	12,310
Subtotals	1,599	1	6,894	205	66	81	16,670
Included Nonwater-Service Area	110	1	370	0	39	131	7,720
Gross Urban and Suburban Area	1,709	2	7,264	205	105	212	24,390
Irrigated Agriculture							
Alfalfa	0	0	0	0	43	0	135,860
Pasture	0	0	0	0	5	0	2,500
Citrus and subtropical	0	0	0	0	575	0	1,760
Truck crops	0	0	0	0	250	0	24,790
Field crops	0	0	0	0	0	0	100,310
Deciduous fruits and nuts	0	0	0	0	0	0	100
Small grains	0	0	0	0	60	0	110,790
Vineyards	0	0	0	0	215	0	80
Subtotals	0	0	0	0	1,148	0	376,190
Fallow	0	0	0	0	18	0	89,530
Included Nonwater-Service Area	0	0	0	0	290	0	66,680
Gross Irrigated Agriculture	0	0	0	0	1,456	0	532,400
GROSS WATER SERVICE AREA	1,709	2	7,264	205	1,561	212	556,790

LAND USE IN GROUND WATER BASINS OF THE COLORADO DESERT AREA IN 1958
(continued)

In acres

Nature and class of land use	Jacumba Valley	Lanfair Valley	Means Valley	Morongo Valley	Needles Valley	Ocotillo Valley	Orcopia Valley
WATER SERVICE AREA							
Urban and Suburban							
Residential	55	0	26	166	225	12	3
Recreational residential	0	0	1,167	205	0	0	0
Commercial	6	0	1	7	40	2	0
Industrial	8	0	0	0	8	0	0
Unsegregated urban and suburban area	5	31	6	7	15	7	0
Subtotals	74	31	1,200	385	288	21	3
Included Nonwater-Service Area	42	6	23	60	416	66	13
Gross Urban and Suburban Area	116	37	1,223	445	704	87	16
Irrigated Agriculture							
Alfalfa	87	0	0	0	38	240	0
Pasture	85	0	0	0	350	0	0
Citrus and subtropical	0	0	0	0	16	0	0
Truck crops	120	0	0	0	0	0	0
Field crops	37	0	0	0	0	0	0
Deciduous fruits and nuts	0	0	0	0	0	0	0
Small grains	115	0	0	0	92	0	0
Vineyards	0	0	0	0	0	0	0
Subtotals	444	0	0	0	496	240	0
Fallow	0	0	0	0	72	0	0
Included Nonwater-Service Area	23	0	75	0	35	23	0
Gross Irrigated Agriculture	467	0	75	0	603	263	0
GROSS WATER SERVICE AREA	583	37	1,298	445	1,307	350	16

LAND USE IN GROUND WATER BASINS OF THE COLORADO DESERT AREA IN 1958
(continued)

In acres

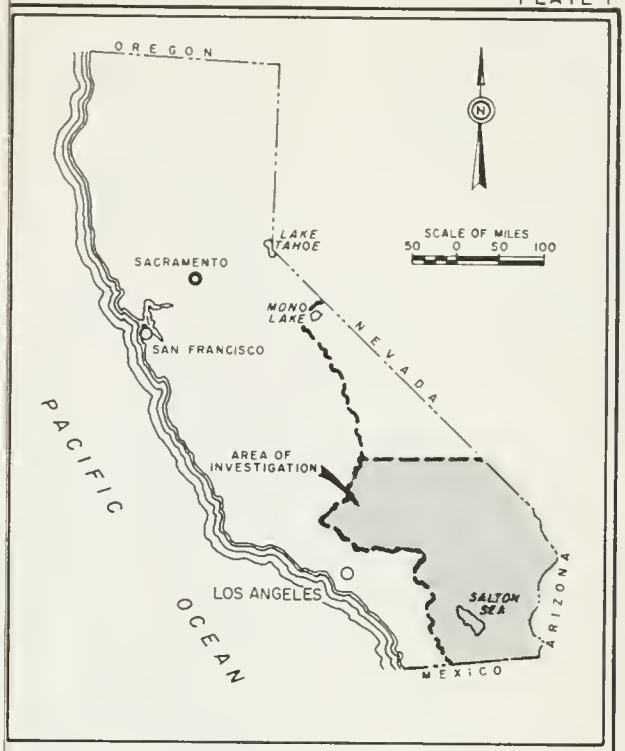
Nature and class of land use	Palo Verde Mesa	Palo Verde Valley	Piute Valley	Quien Sabe Point Valley	Rice Valley	San Felipe Valley	Terwilliger Valley
WATER SERVICE AREA							
Urban and Suburban							
Residential	111	515	3	25	10	8	5
Recreational residential	0	0	0	0	0	73	0
Commercial	6	140	1	6	4	6	0
Industrial	0	56	0	0	0	0	0
Unsegregated urban and suburban area	0	815	0	24	0	13	17
Subtotals	117	1,526	4	55	14	100	22
Included Nonwater-Service Area	466	1,040	1	14	17	8	4
Gross Urban and Suburban Area	583	2,566	5	69	31	108	26
Irrigated Agriculture							
Alfalfa	49	20,820	0	760	97	0	0
Pasture	120	7,280	0	140	0	13	0
Citrus and subtropical	29	125	0	0	0	0	0
Truck crops	27	4,020	0	1	0	2	0
Field crops	420	21,320	0	245	7	0	0
Deciduous fruits and nuts	0	10	0	0	0	55	0
Small grains	29	4,350	0	0	0	30	0
Vineyards	0	0	0	0	0	0	0
Subtotals	674	57,925	0	1,146	104	100	0
Fallow	170	15,070	0	50	0	0	0
Included Nonwater-Service Area	195	10,070	0	450	58	6	0
Gross Irrigated Agriculture	1,039	83,055	0	1,646	162	106	0
GROSS WATER SERVICE AREA	1,622	85,621	5	1,715	193	214	26

LAND USE IN GROUND WATER BASINS OF THE COLORADO DESERT AREA IN 1958
(continued)

In acres

Nature and class of land use	Twentynine Palms Valley	Vallecito-Carrizo Valley	Vidal Valley	Ward Valley	Warren Valley	West Salton Sea Valley	Yuma Valley
WATER SERVICE AREA							
Urban and Suburban							
Residential	695	81	12	17	215	3	71
Recreational residential	680	0	0	0	45	0	0
Commercial	66	13	3	0	16	2	37
Industrial	0	0	0	0	0	0	0
Unsegregated urban and suburban area	93	49	0	4	54	0	121
Subtotals	1,534	143	15	21	330	5	229
Included Nonwater-Service Area	295	39	31	25	95	29	110
Gross Urban and Suburban Area	1,829	182	46	46	425	34	339
Irrigated Agriculture							
Alfalfa	0	78	0	0	0	0	4,050
Pasture	0	245	0	0	0	0	970
Citrus and subtropical	0	0	0	0	0	0	280
Truck crops	0	0	0	0	0	0	195
Field crops	0	0	0	0	0	0	4,100
Deciduous fruits and nuts	0	0	0	0	0	0	25
Small grains	0	0	0	0	0	0	1,890
Vineyards	0	0	0	0	0	0	22
Subtotals	0	323	0	0	0	0	11,532
Fallow	0	0	0	0	0	0	1,240
Included Nonwater-Service Area	0	17	0	0	41	0	1,570
Gross Irrigated Agriculture	0	340	0	0	41	0	14,342
GROSS WATER SERVICE AREA	1,829	522	46	46	466	34	14,681

PLATE 1



LOCATION MAP

LEGEND

BOUNDARY OF INVESTIGATIONAL AREA

BOUNDARY OF HYDROGRAPHIC AREA

BOUNDARY OF HYDROGRAPHIC UNIT

7-6 HYDROGRAPHIC AREA AND UNIT NUMBER

STATE OF CALIFORNIA
DEPARTMENT OF WATER RESOURCES
SOUTHERN DISTRICT

DESERT AREAS OF SOUTHEASTERN CALIFORNIA LAND AND WATER USE SURVEY

AREA OF INVESTIGATION AND HYDROGRAPHIC UNITS

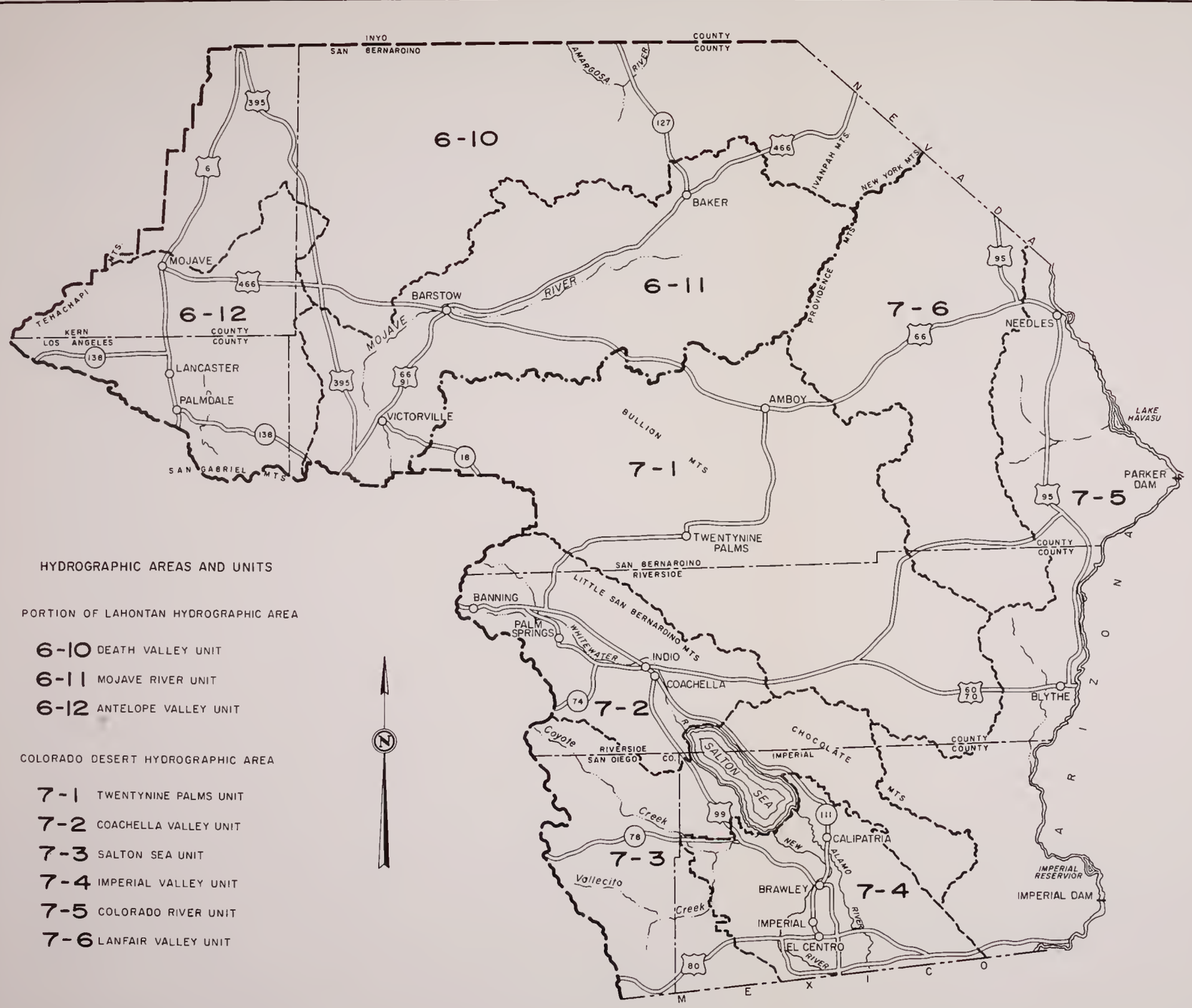
SCALE OF MILES
10 0 10 20 30

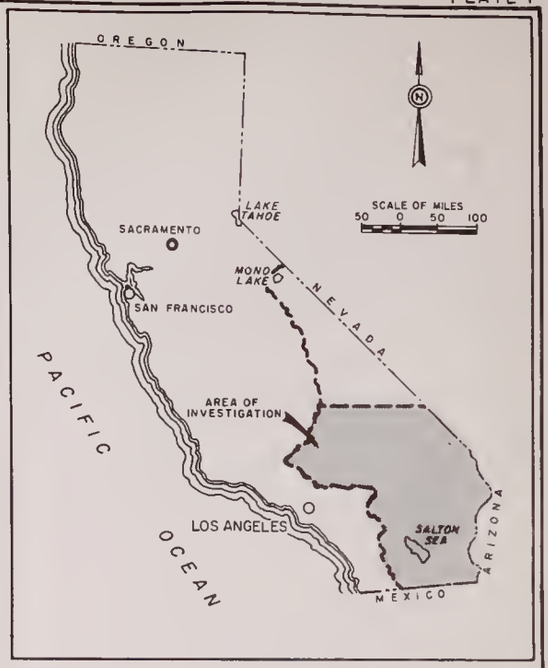
1962

LAND USE IN GROUND WATER BASINS OF THE COLORADO DESERT AREA IN 1958
(continued)

In acres

Nature and class of land use	Twentynine Palms Valley	Vallecito-Carrizo Valley	Vidal Valley	Ward Valley	Warren Valley	West Salton Sea Valley	Yuma Valley
WATER SERVICE AREA							
Urban and Suburban							
Residential	695	81	12	17	215	3	71
Recreational residential	680	0	0	0	45	0	0
Commercial	66	13	3	0	16	2	37
Industrial	0	0	0	0	0	0	0
Unsegregated urban and suburban area	93	49	0	4	54	0	121
Subtotals	1,534	143	15	21	330	5	229
Included Nonwater-Service Area	295	39	31	25	95	29	110
Gross Urban and Suburban Area	1,829	182	46	46	425	34	339
Irrigated Agriculture							
Alfalfa	0	78	0	0	0	0	4,050
Pasture	0	245	0	0	0	0	970
Citrus and subtropical	0	0	0	0	0	0	280
Truck crops	0	0	0	0	0	0	195
Field crops	0	0	0	0	0	0	4,100
Deciduous fruits and nuts	0	0	0	0	0	0	25
Small grains	0	0	0	0	0	0	1,890
Vineyards	0	0	0	0	0	0	22
Subtotals	0	323	0	0	0	0	11,532
Fallow	0	0	0	0	0	0	1,240
Included Nonwater-Service Area	0	17	0	0	41	0	1,570
Gross Irrigated Agriculture	0	340	0	0	41	0	14,342
GROSS WATER SERVICE AREA	1,829	522	46	46	466	34	14,681





LOCATION MAP

HYDROGRAPHIC AREAS AND UNITS

PORTION OF LAHONTAN HYDROGRAPHIC AREA

- 6-10 DEATH VALLEY UNIT
- 6-11 MOJAVE RIVER UNIT
- 6-12 ANTELOPE VALLEY UNIT

COLORADO DESERT HYDROGRAPHIC AREA

- 7-1 TWENTYNINE PALMS UNIT
- 7-2 COACHELLA VALLEY UNIT
- 7-3 SALTON SEA UNIT
- 7-4 IMPERIAL VALLEY UNIT
- 7-5 COLORADO RIVER UNIT
- 7-6 LANFAIR VALLEY UNIT

LEGEND

- BOUNDARY OF INVESTIGATIONAL AREA
- BOUNDARY OF HYDROGRAPHIC AREA
- BOUNDARY OF HYDROGRAPHIC UNIT
- 7-6 HYDROGRAPHIC AREA AND UNIT NUMBER

STATE OF CALIFORNIA
DEPARTMENT OF WATER RESOURCES
SOUTHERN DISTRICT

DESERT AREAS OF
SOUTHEASTERN CALIFORNIA
LAND AND WATER USE SURVEY

AREA OF INVESTIGATION AND HYDROGRAPHIC UNITS

SCALE OF MILES
10 0 10 20 30

1962

LEGEND

BOUNDARY OF INVESTIGATIONAL AREA

BOUNDARY OF HYDROGRAPHIC AREA

BOUNDARY OF GROUND WATER BASIN

LUCERNE VALLEY — GROUND WATER BASIN NAME

WATER-BEARING SEDIMENTS

STATE OF CALIFORNIA

DEPARTMENT OF WATER RESOURCES

SOUTHERN DISTRICT

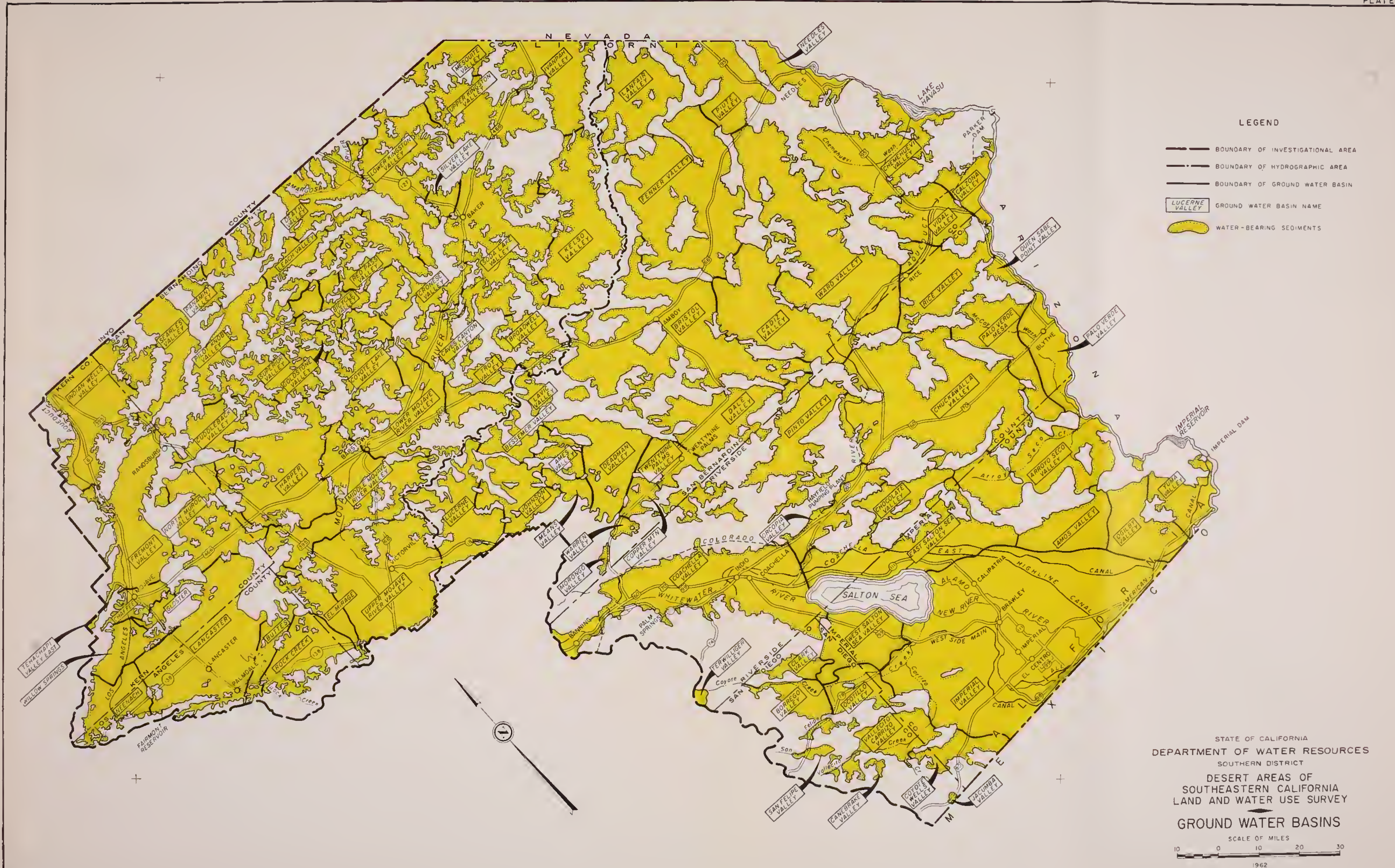
DESERT AREAS OF SOUTHEASTERN CALIFORNIA LAND AND WATER USE SURVEY

GROUND WATER BASINS

SCALE OF MILES

10 0 10 20 30

1962


LEGEND
BOUNDARY OF INVESTIGATIONAL AREA
BOUNDARY OF HYDROGRAPHIC AREA
BOUNDARY OF GROUND WATER BASIN
LUCERNE VALLEY
GROUND WATER BASIN NAME
WATER-BEARING SEDIMENTS
STATE OF CALIFORNIA
DEPARTMENT OF WATER RESOURCES
SOUTHERN DISTRICT
DESERT AREAS OF
SOUTHEASTERN CALIFORNIA
LAND AND WATER USE SURVEY
GROUND WATER BASINS
SCALE OF MILES
10 0 10 20 30
1962
NEVADA
CALIFORNIA
ARIZONA
MEXICO
SALTON SEA
LAKE HAVASU
PARKER DAM
IMPERIAL RESERVOIR
IMPERIAL DAM
FAIRMONT RESERVOIR
NEEDLES VALLEY
IVANPAH VALLEY
MESQUITE VALLEY
LANFAIR VALLEY
PIUTE VALLEY
FENNER VALLEY
KELSO VALLEY
BRISTOL VALLEY
CADIZ VALLEY
WARD VALLEY
RICE VALLEY
VIDAL VALLEY
CALZONA VALLEY
QUIEN SABE POINT VALLEY
PALO VERDE VALLEY
PALO VERDE MESA
CHUCKAWALLA VALLEY
PINTO VALLEY
DALE VALLEY
DEADMAN VALLEY
AMES VALLEY
BESSEMER VALLEY
JOHNSON VALLEY
LUCERNE VALLEY
MEANS VALLEY
WARREN VALLEY
MORONGO VALLEY
COPPER MTN VALLEY
TWENTYNINE PALMS VALLEY
COACHELLA VALLEY
OROCOPIA VALLEY
CHOCOLATE VALLEY
EAST SALTON SEA VALLEY
WEST SALTON SEA VALLEY
AMOS VALLEY
OGILBY VALLEY
YUMA VALLEY
ARROYO SECO VALLEY
IMPERIAL VALLEY
OCOTILLO VALLEY
BORREGO VALLEY
CLARK VALLEY
TERWILLIGER VALLEY
SAN FELIPE VALLEY
CANEBRAKE VALLEY
VALLECITO CARRIZO VALLEY
COYOTE WELLS VALLEY
JACUMBA VALLEY
HARPER VALLEY
LOWER MOJAVE RIVER VALLEY
MIDDLE MOJAVE RIVER VALLEY
UPPER MOJAVE RIVER VALLEY
EL MIRAGE VALLEY
LANCASTER
BUTTES
ROCK CREEK
FREMONT VALLEY
CUDDLEBACK VALLEY
NORTH MUROC VALLEY
INDIAN WELLS VALLEY
SEARLES VALLEY
PANAMINT VALLEY
PILOT KNOB VALLEY
SUPERIOR VALLEY
GOLDSTONE VALLEY
COYOTE LAKE VALLEY
CAVES CANYON VALLEY
TROY VALLEY
BROADWELL VALLEY
LAVIC VALLEY
SODA LAKE VALLEY
SILVER LAKE VALLEY
LOWER KINGSTON VALLEY
UPPER KINGSTON VALLEY
LEACH VALLEY
DEATH VALLEY
RED PASS VALLEY
BICYCLE VALLEY
AVAWATZ VALLEY
TEHACHAPI VALLEY EAST
WILLOW SPRINGS
NEENACH
CHAFFEE
GLOSTER
NEEDLES
BAKER
AMBOY
BLYTHE
RICE
INDIO
COACHELLA
BANNING
PALM SPRINGS
BRAWLEY
CALIPATRIA
IMPERIAL
EL CENTRO
BARSTOW
VICTORVILLE
MOJAVE
LANCASTER
PALMDALE
RANDSBURG
TWENTYNINE PALMS
MAYFIELD PUMPING PLANT
COLORADO RIVER AQUEDUCT
COACHELLA CANAL
EAST HIGHLINE CANAL
ALL AMERICAN CANAL
WEST SIDE MAIN CANAL
ALAMO RIVER
NEW RIVER
WHITEWATER RIVER
SAN BERNARDINO COUNTY
RIVERSIDE COUNTY
IMPERIAL COUNTY
SAN DIEGO COUNTY
KERN COUNTY
LOS ANGELES COUNTY
INYO COUNTY

LOCATION MAP

LEGEND

- BOUNDARY OF INVESTIGATIONAL AREA
- BOUNDARY OF HYDROGRAPHIC AREA
- BOUNDARY OF HYDROGRAPHIC UNIT
- BOUNDARY OF FEDERAL AND STATE LANDS
- BOUNDARY OF AREA SURVEYED IN 1957
- IRRIGATED AGRICULTURE
- URBAN RESIDENTIAL
- COMMERCIAL
- INDUSTRIAL - MANUFACTURING AND PROCESSING
- INDUSTRIAL - EXTRACTIVE, STORAGE, AND TRANSPORTATION
- RECREATIONAL RESIDENTIAL
- MILITARY RESERVATIONS
- 7-6 HYDROGRAPHIC AREA AND UNIT NUMBER

STATE OF CALIFORNIA
DEPARTMENT OF WATER RESOURCES
SOUTHERN DISTRICT

DESERT AREAS OF SOUTHEASTERN CALIFORNIA LAND AND WATER USE SURVEY

PRESENT LAND USE 1958

SCALE OF MILES
4 0 4 8 12

1962

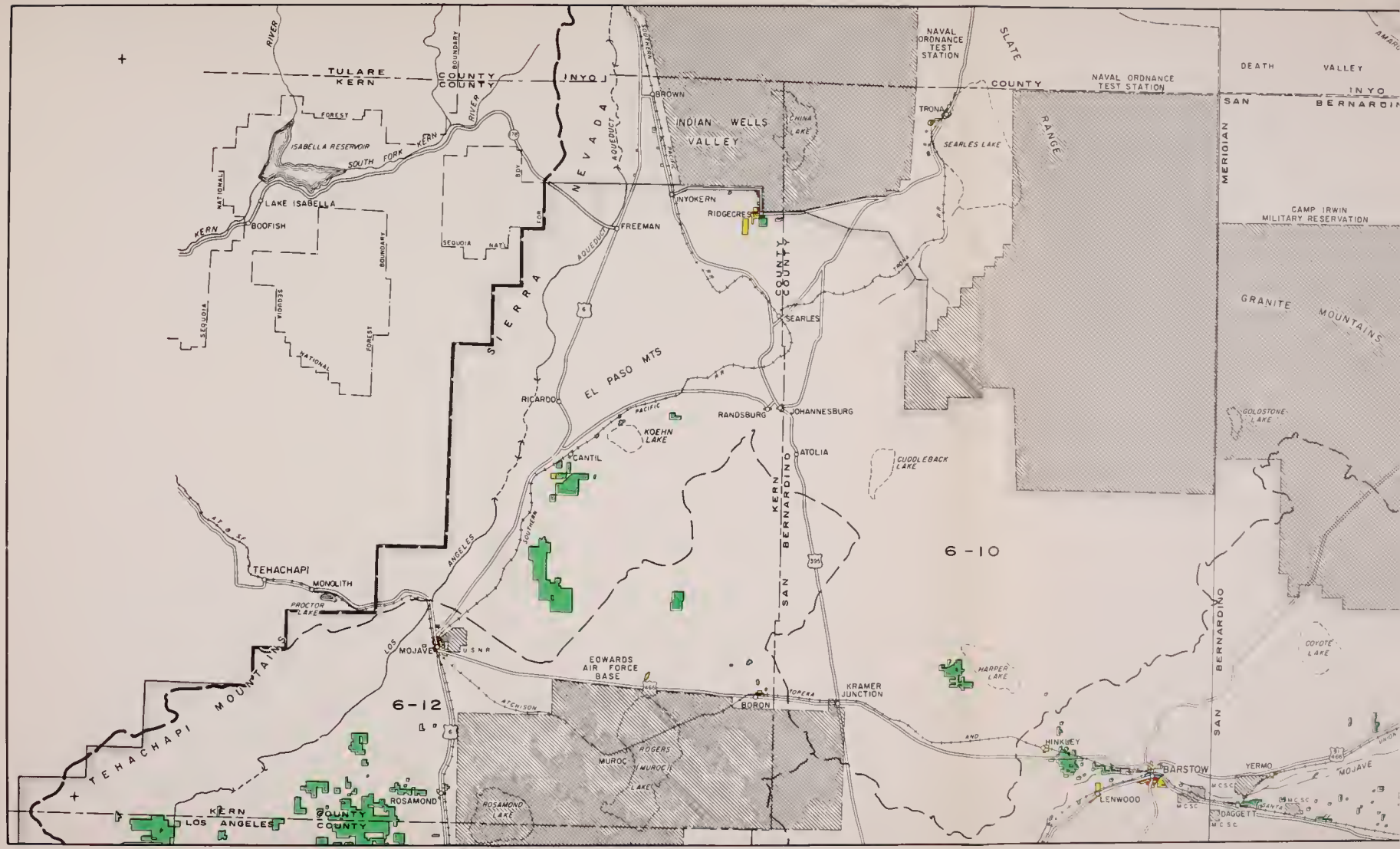
HYDROGRAPHIC AREAS AND UNITS

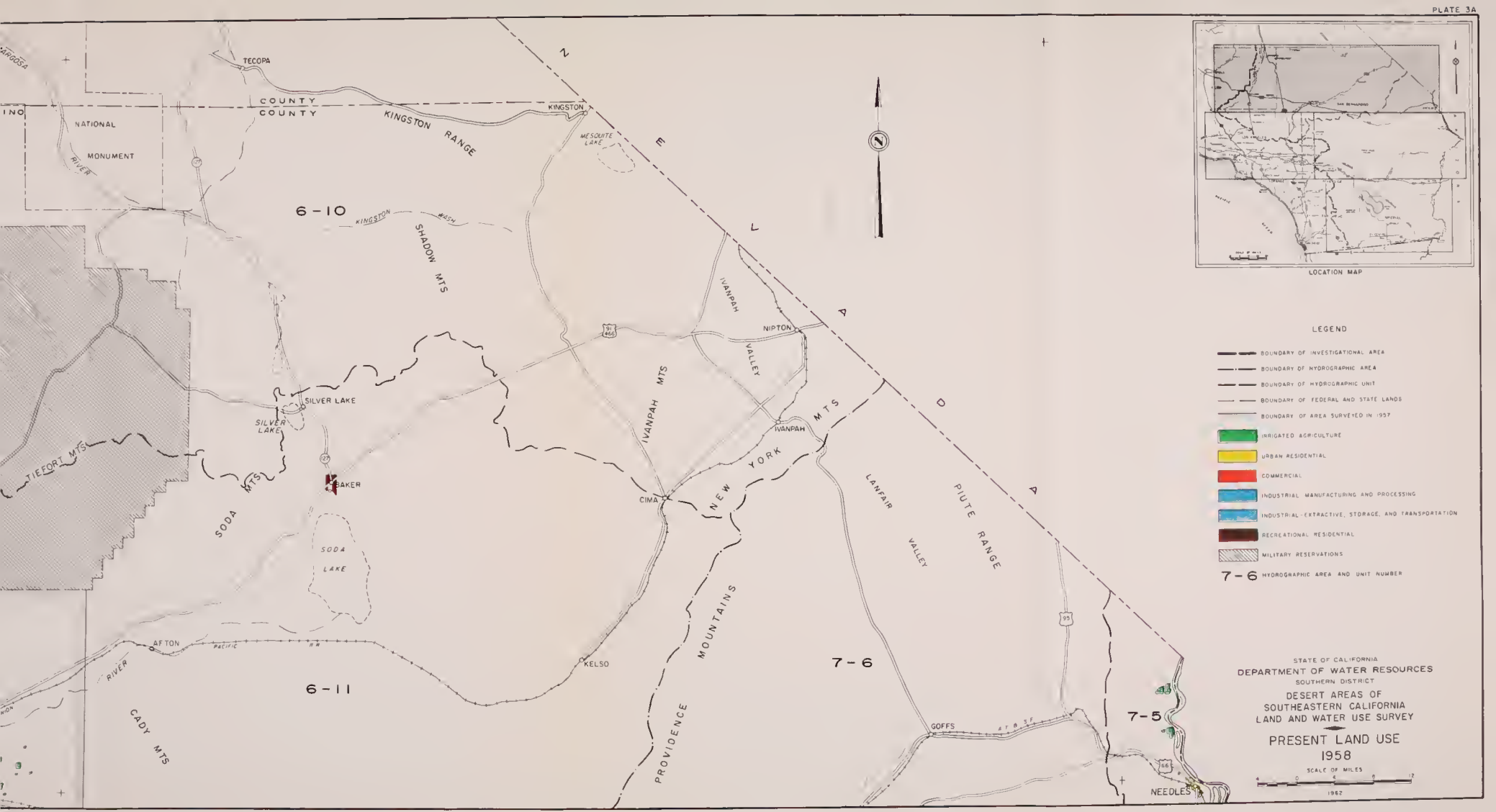
PORTION OF LAHONTAN HYDROGRAPHIC AREA

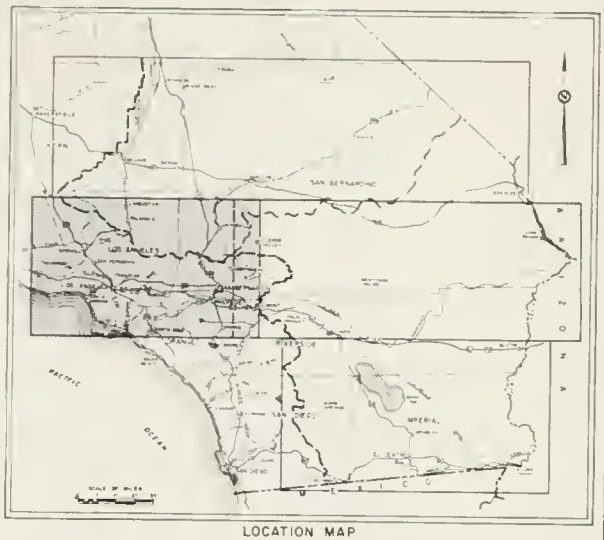
- 6-10 DEATH VALLEY UNIT
- 6-11 MOJAVE RIVER UNIT
- 6-12 ANTELOPE VALLEY UNIT

COLORADO DESERT HYDROGRAPHIC AREA

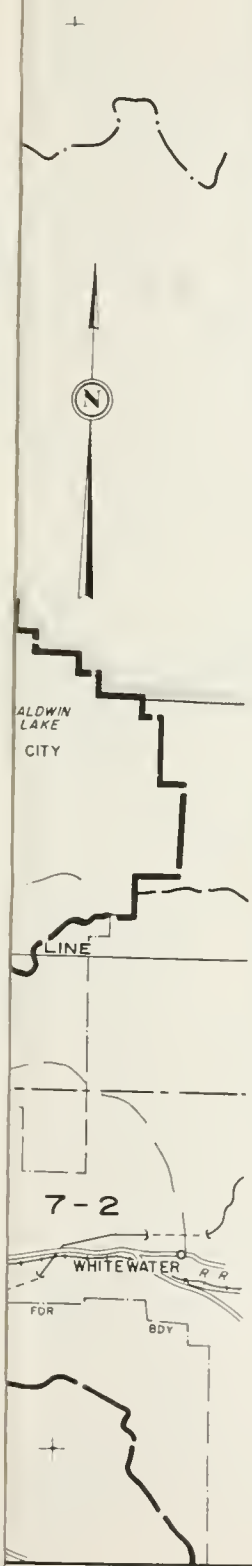
- 7-1 TWENTYNINE PALMS UNIT
- 7-2 COACHELLA VALLEY UNIT
- 7-3 SALTON SEA UNIT
- 7-4 IMPERIAL VALLEY UNIT
- 7-5 COLORADO RIVER UNIT
- 7-6 LANFAIR VALLEY UNIT




TECOPA
COUNTY
COUNTY
KINGSTON
KINGSTON RANGE
MESQUITE LAKE
NATIONAL
MONUMENT
RIVER
6-10
KINGSTON WASH
SHADOW MTS
IVANPAH
VALLEY
NIPTON
IVANPAH MTS
SILVER LAKE
SILVER LAKE
TIEFORT MTS
SODA MTS
BAKER
CIMA
NEW YORK MTS
IVANPAH
LANFAIR VALLEY
PIUTE RANGE
SODA LAKE
AFTON
PACIFIC RR
RIVER
KELSO
6-11
CADY MTS
PROVIDENCE MOUNTAINS
7-6
GOFFS
ATSF
7-5
NEEDLES
N E V A D A
LOCATION MAP
LEGEND
BOUNDARY OF INVESTIGATIONAL AREA
BOUNDARY OF HYDROGRAPHIC AREA
BOUNDARY OF HYDROGRAPHIC UNIT
BOUNDARY OF FEDERAL AND STATE LANDS
BOUNDARY OF AREA SURVEYED IN 1957
IRRIGATED AGRICULTURE
URBAN RESIDENTIAL
COMMERCIAL
INDUSTRIAL MANUFACTURING AND PROCESSING
INDUSTRIAL - EXTRACTIVE, STORAGE, AND TRANSPORTATION
RECREATIONAL RESIDENTIAL
MILITARY RESERVATIONS
7-6 HYDROGRAPHIC AREA AND UNIT NUMBER
STATE OF CALIFORNIA
DEPARTMENT OF WATER RESOURCES
SOUTHERN DISTRICT
DESERT AREAS OF
SOUTHEASTERN CALIFORNIA
LAND AND WATER USE SURVEY
PRESENT LAND USE
1958
SCALE OF MILES
1962



LOCATION MAP



LEGEND

- BOUNDARY OF INVESTIGATIONAL AREA
- BOUNDARY OF HYDROGRAPHIC AREA
- BOUNDARY OF HYDROGRAPHIC UNIT
- BOUNDARY OF FEDERAL AND STATE LANDS
- BOUNDARY OF AREA SURVEYED IN 1957
- IRRIGATED AGRICULTURE
- URBAN RESIDENTIAL
- COMMERCIAL
- INDUSTRIAL - MANUFACTURING AND PROCESSING
- INDUSTRIAL - EXTRACTIVE, STORAGE, AND TRANSPORTATION
- RECREATIONAL RESIDENTIAL
- MILITARY RESERVATIONS
- 6-12 HYDROGRAPHIC AREA AND UNIT NUMBER

STATE OF CALIFORNIA
DEPARTMENT OF WATER RESOURCES
SOUTHERN DISTRICT

DESERT AREAS OF SOUTHEASTERN CALIFORNIA LAND AND WATER USE SURVEY

PRESENT LAND USE 1958

SCALE OF MILES
4 0 4 8 12

1962

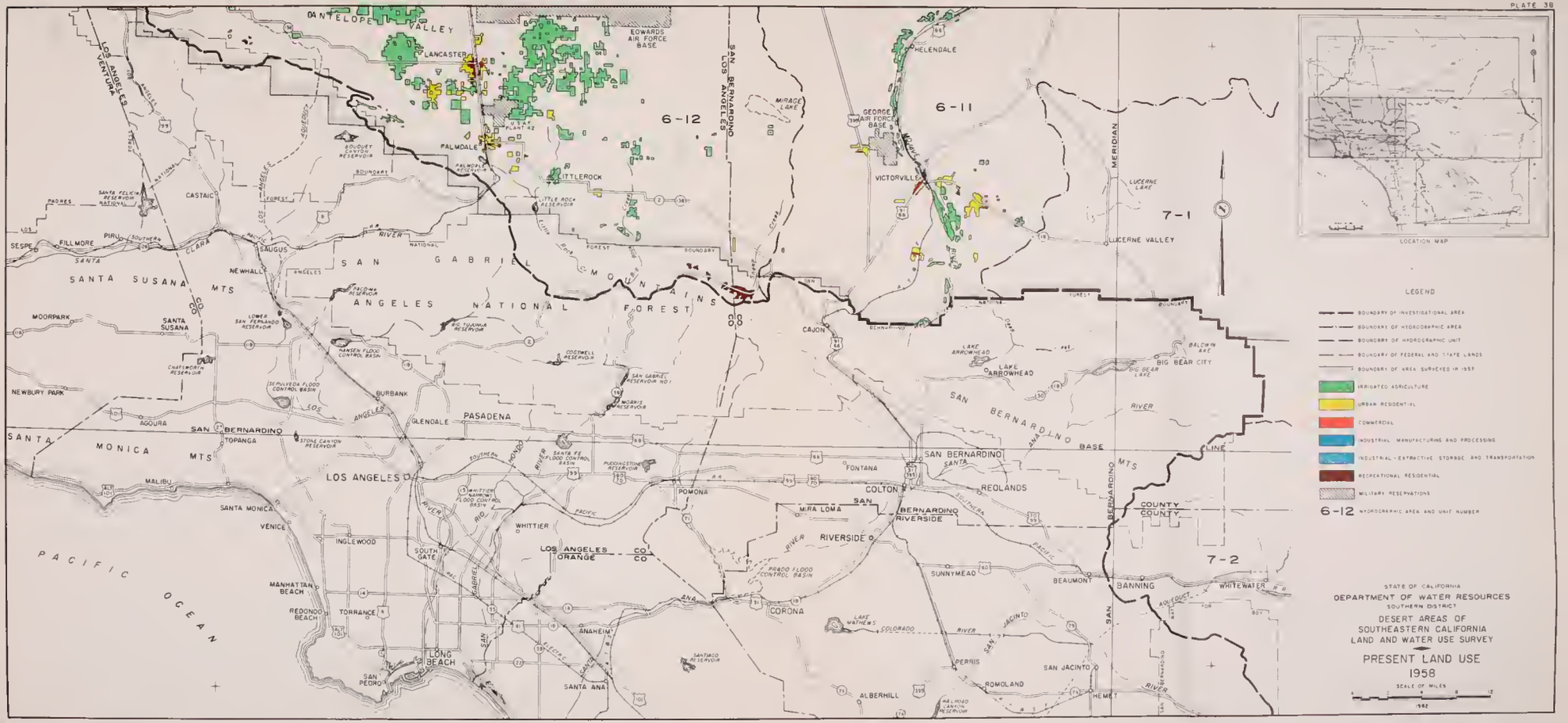
HYDROGRAPHIC AREAS AND UNITS

PORTION OF LAHONTAN HYDROGRAPHIC AREA

6-10 DEATH VALLEY UNIT
6-11 MOJAVE RIVER UNIT
6-12 ANTELOPE VALLEY UNIT

COLORADO DESERT HYDROGRAPHIC AREA

7-1 TWENTYNINE PALMS UNIT
7-2 COACHELLA VALLEY UNIT
7-3 SALTON SEA UNIT
7-4 IMPERIAL VALLEY UNIT
7-5 COLORADO RIVER UNIT
7-6 LANFAIR VALLEY UNIT



LOCATION MAP

COLORADO RIVER

HAVASU LAKE

WHIPPLE MOUNTAINS

GENE WASH RESERVOIR

PARKER DAM

COPPER BASIN RESERVOIR

VIDAL

7-5

LEGEND

- BOUNDARY OF INVESTIGATIONAL AREA
- BOUNDARY OF HYDROGRAPHIC AREA
- BOUNDARY OF HYDROGRAPHIC UNIT
- BOUNDARY OF FEDERAL AND STATE LANDS
- BOUNDARY OF MAJOR WATER AGENCIES
- BOUNDARY OF AREA SURVEYED IN 1957
- IRRIGATED AGRICULTURE
- URBAN RESIDENTIAL
- URBAN RESIDENTIAL - LESS THAN 10 PER CENT DEVELOPED
- COMMERCIAL
- INDUSTRIAL - MANUFACTURING AND PROCESSING
- INDUSTRIAL - EXTRACTIVE, STORAGE, AND TRANSPORTATION
- RECREATIONAL RESIDENTIAL
- MILITARY RESERVATIONS
- 6-11 HYDROGRAPHIC AREA AND UNIT NUMBER

STATE OF CALIFORNIA
DEPARTMENT OF WATER RESOURCES
SOUTHERN DISTRICT

DESERT AREAS OF SOUTHEASTERN CALIFORNIA LAND AND WATER USE SURVEY

PRESENT LAND USE 1958

SCALE OF MILES

4 0 4 8 12

1962

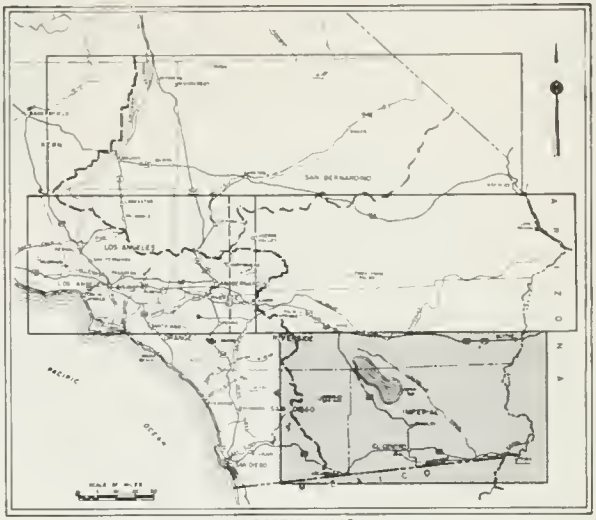
HYDROGRAPHIC AREAS AND UNITS

PORTION OF LAHONTAN HYDROGRAPHIC AREA

6-10 DEATH VALLEY UNIT
6-11 MOJAVE RIVER UNIT
6-12 ANTELOPE VALLEY UNIT

COLORADO DESERT HYDROGRAPHIC AREA

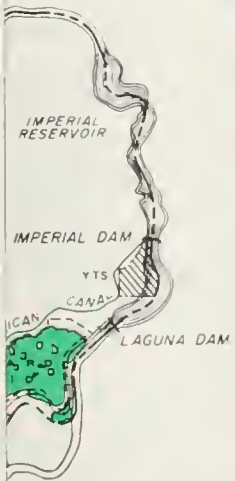
7-1 TWENTYNINE PALMS UNIT
7-2 COACHELLA VALLEY UNIT
7-3 SALTON SEA UNIT
7-4 IMPERIAL VALLEY UNIT
7-5 COLORADO RIVER UNIT
7-6 LANFAIR VALLEY UNIT



LOCATION MAP

LEGEND

- BOUNDARY OF INVESTIGATIONAL AREA
- BOUNDARY OF HYDROGRAPHIC UNIT
- BOUNDARY OF FEDERAL AND STATE LANDS
- BOUNDARY OF MAJOR WATER AGENCIES
- IRRIGATED AGRICULTURE
- URBAN RESIDENTIAL
- URBAN RESIDENTIAL - LESS THAN 10 PER CENT DEVELOPED
- COMMERCIAL
- INDUSTRIAL - MANUFACTURING AND PROCESSING
- INDUSTRIAL - EXTRACTIVE, STORAGE, AND TRANSPORTATION
- RECREATIONAL RESIDENTIAL
- MILITARY RESERVATIONS
- 7-2 HYDROGRAPHIC AREA AND UNIT NUMBER



STATE OF CALIFORNIA
DEPARTMENT OF WATER RESOURCES
SOUTHERN DISTRICT

DESERT AREAS OF SOUTHEASTERN CALIFORNIA LAND AND WATER USE SURVEY

PRESENT LAND USE 1958

SCALE OF MILES
4 0 4 8 12

1962

PLATE 30

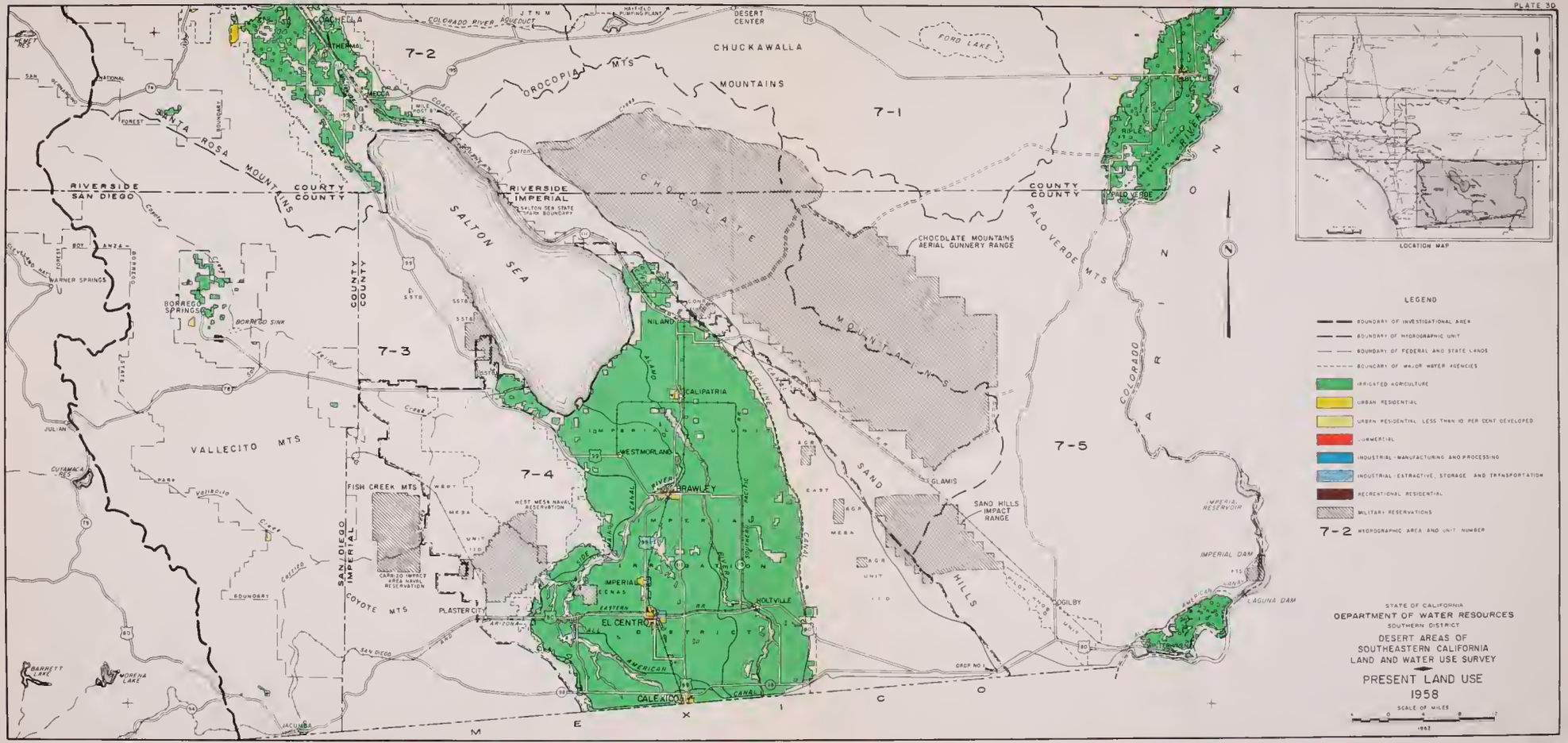
HYDROGRAPHIC AREAS AND UNITS

PORTION OF LAHONTAN HYDROGRAPHIC AREA

6-10 DEATH VALLEY UNIT
6-11 MOJAVE RIVER UNIT
6-12 ANTELOPE VALLEY UNIT

COLORADO DESERT HYDROGRAPHIC AREA

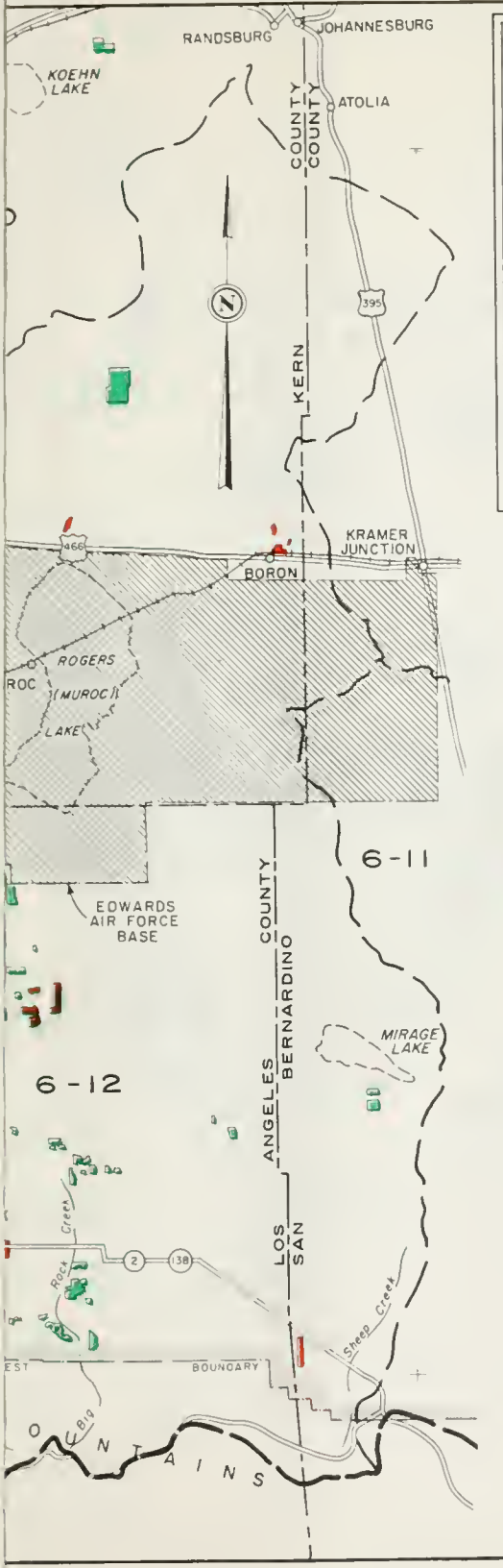
7-1 TWENTYNINE PALMS UNIT
7-2 COACHELLA VALLEY UNIT
7-3 SALTON SEA UNIT
7-4 IMPERIAL VALLEY UNIT
7-5 COLORADO RIVER UNIT
7-6 LANFAIR VALLEY UNIT



STATE OF CALIFORNIA
DEPARTMENT OF WATER RESOURCES
SOUTHERN DISTRICT
DESERT AREAS OF
SOUTHEASTERN CALIFORNIA
LAND AND WATER USE SURVEY

PRESENT LAND USE
1958

SCALE OF MILES
0 4 8 12
1962



LOCATION MAP

LEGEND

- BOUNDARY OF INVESTIGATIONAL AREA
- BOUNDARY OF HYDROGRAPHIC UNIT
- BOUNDARY OF FEDERAL AND STATE LANDS
- BOUNDARY OF AREA SURVEYED IN 1957
- IRRIGATED AGRICULTURAL EXPANSION
- URBAN AND SUBURBAN EXPANSION
- IRRIGATED AGRICULTURE TO NON-IRRIGATED USE
- MILITARY RESERVATIONS
- 6-12 HYDROGRAPHIC AREA AND UNIT NUMBER

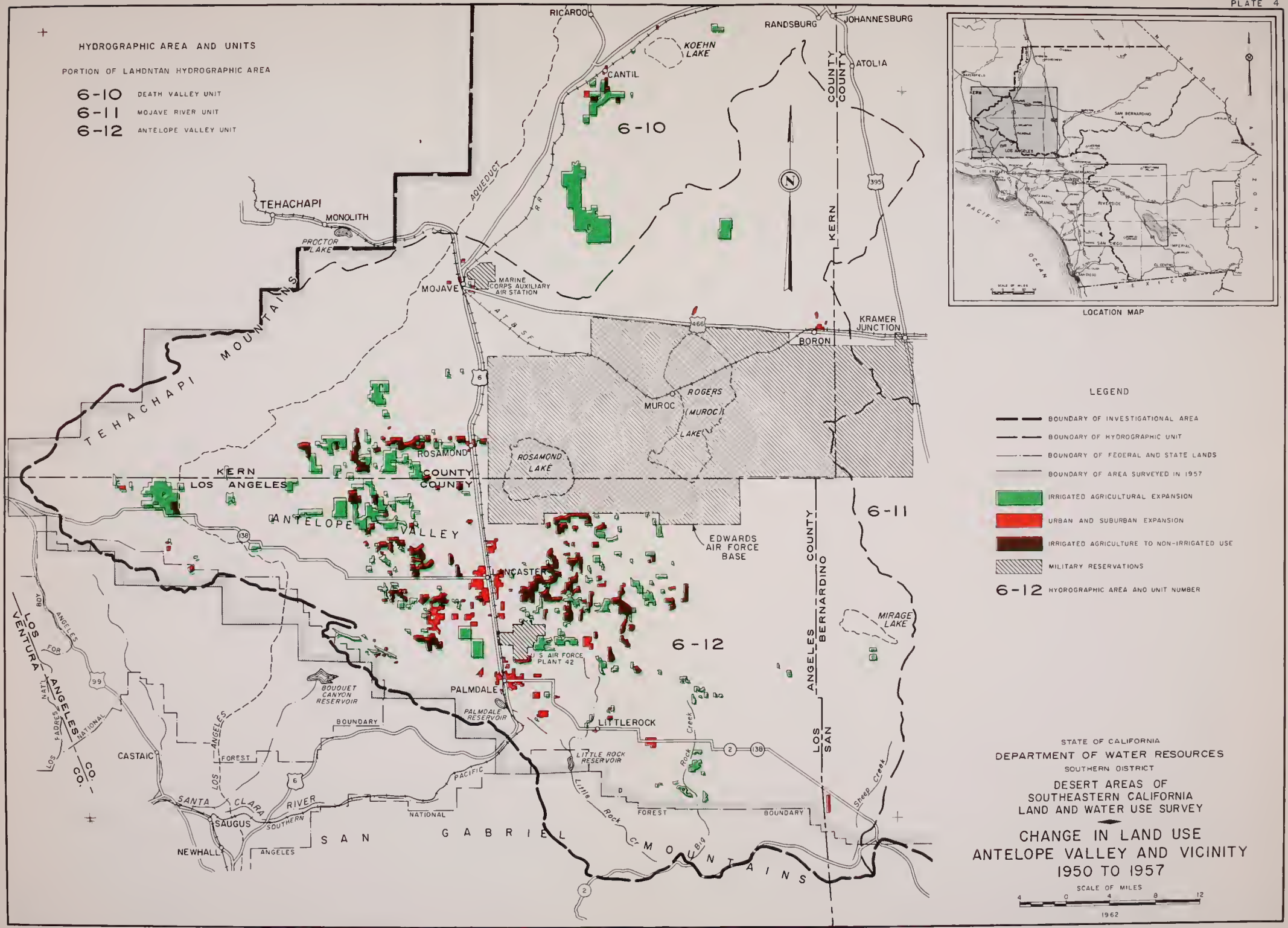
STATE OF CALIFORNIA
DEPARTMENT OF WATER RESOURCES
SOUTHERN DISTRICT

DESERT AREAS OF SOUTHEASTERN CALIFORNIA LAND AND WATER USE SURVEY

CHANGE IN LAND USE ANTELOPE VALLEY AND VICINITY 1950 TO 1957

SCALE OF MILES
4 0 4 8 12

1962


HYDROGRAPHIC AREA AND UNITS
PORTION OF LAHONTAN HYDROGRAPHIC AREA
6-10 DEATH VALLEY UNIT
6-11 MOJAVE RIVER UNIT
6-12 ANTELOPE VALLEY UNIT
RICAROO
RANDSBURG
JOHANNESBURG
KOEHN LAKE
CANTIL
ATOLIA
6-10
TEHACHAPI
MONOLITH
PROCTOR LAKE
AQUEDUCT
MOJAVE
MARINE CORPS AUXILIARY AIR STATION
A T & S F
KERN COUNTY
KRAMER JUNCTION
BORON
TEHACHAPI MOUNTAINS
MUROC
ROGERS (MUROC) LAKE
ROSAMOND
ROSAMOND LAKE
KERN COUNTY
LOS ANGELES COUNTY
ANTELOPE VALLEY
6-11
EDWARDS AIR FORCE BASE
LANCASTER
MIRAGE LAKE
U S AIR FORCE PLANT 42
6-12
PALMDALE
BOUQUET CANYON RESERVOIR
PALMDALE RESERVOIR
LITTLEROCK
LITTLE ROCK RESERVOIR
LOS ANGELES COUNTY
SAN BERNARDINO COUNTY
LOS ANGELES NATIONAL FOREST BOUNDARY
CASTAIC
SANTA CLARA RIVER
SAUGUS
NEWHALL
SAN GABRIEL MOUNTAINS
PACIFIC OCEAN
LOCATION MAP
LEGEND
BOUNDARY OF INVESTIGATIONAL AREA
BOUNDARY OF HYDROGRAPHIC UNIT
BOUNDARY OF FEDERAL AND STATE LANDS
BOUNDARY OF AREA SURVEYED IN 1957
IRRIGATED AGRICULTURAL EXPANSION
URBAN AND SUBURBAN EXPANSION
IRRIGATED AGRICULTURE TO NON-IRRIGATED USE
MILITARY RESERVATIONS
6-12 HYDROGRAPHIC AREA AND UNIT NUMBER
STATE OF CALIFORNIA
DEPARTMENT OF WATER RESOURCES
SOUTHERN DISTRICT
DESERT AREAS OF SOUTHEASTERN CALIFORNIA LAND AND WATER USE SURVEY
CHANGE IN LAND USE
ANTELOPE VALLEY AND VICINITY
1950 TO 1957
SCALE OF MILES
4 0 4 8 12
1962

LOCATION MAP

RIVER

LEGEND

- BOUNDARY OF INVESTIGATIONAL AREA
- BOUNDARY OF HYDROGRAPHIC UNIT
- BOUNDARY OF FEDERAL AND STATE LANDS
- BOUNDARY OF MAJOR WATER AGENCIES
- IRRIGATED AGRICULTURAL EXPANSION
- URBAN AND SUBURBAN EXPANSION
- URBAN RESIDENTIAL EXPANSION (WHERE DEVELOPMENT IS LESS THAN 10 PER CENT)
- IRRIGATED AGRICULTURE TO NON-IRRIGATED USE
- MILITARY RESERVATION
- 7-6 HYDROGRAPHIC AREA AND UNIT NUMBER

STATE OF CALIFORNIA
DEPARTMENT OF WATER RESOURCES
SOUTHERN DISTRICT

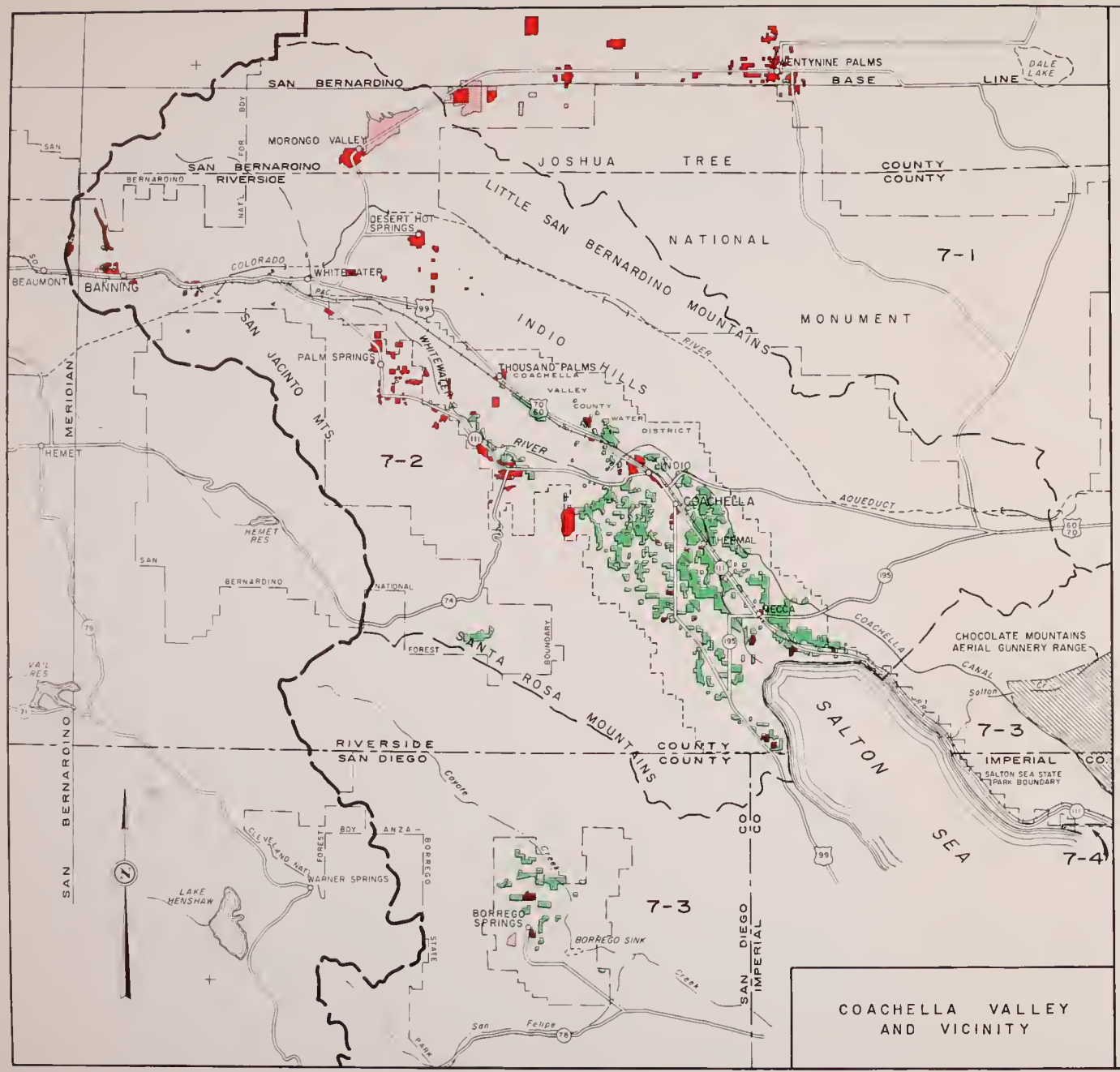
DESERT AREAS OF SOUTHEASTERN CALIFORNIA LAND AND WATER USE SURVEY

CHANGE IN LAND USE COACHELLA AND PALO VERDE VALLEYS AND VICINITIES 1950 TO 1958

SCALE OF MILES

4 0 4 8 12

1962

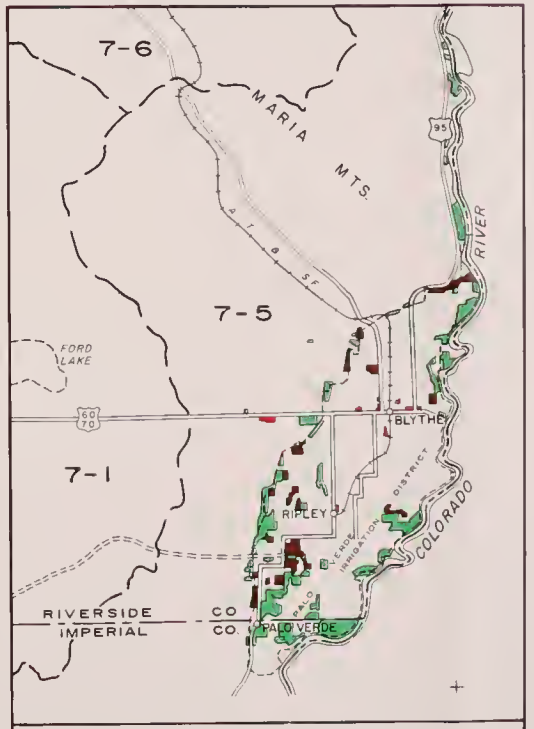


COACHELLA VALLEY AND VICINITY

HYDROGRAPHIC AREA AND UNITS

COLORADO DESERT HYDROGRAPHIC AREA

7-1	TWENTYNINE PALMS UNIT
7-2	COACHELLA VALLEY UNIT
7-3	SALTON SEA UNIT
7-4	IMPERIAL VALLEY UNIT
7-5	COLORADO RIVER UNIT
7-6	LANFAIR VALLEY UNIT



PALO VERDE VALLEY AND VICINITY

LOCATION MAP

LEGEND

- BOUNDARY OF INVESTIGATIONAL AREA
- BOUNDARY OF HYDROGRAPHIC UNIT
- BOUNDARY OF FEDERAL AND STATE LANDS
- BOUNDARY OF MAJOR WATER AGENCIES
- IRRIGATED AGRICULTURAL EXPANSION
- URBAN AND SUBURBAN EXPANSION
- URBAN RESIDENTIAL EXPANSION (WHERE DEVELOPMENT IS LESS THAN 10 PER CENT)
- IRRIGATED AGRICULTURE TO NON-IRRIGATED USE
- MILITARY RESERVATION
- 7-6 HYDROGRAPHIC AREA AND UNIT NUMBER

STATE OF CALIFORNIA
DEPARTMENT OF WATER RESOURCES
SOUTHERN DISTRICT

DESERT AREAS OF
SOUTHEASTERN CALIFORNIA
LAND AND WATER USE SURVEY

CHANGE IN LAND USE COACHELLA AND PALO VERDE VALLEYS AND VICINITIES 1950 TO 1958

SCALE OF MILES
4 0 4 8 12

1962